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RADIOLOGICAL HEALTH DATA AND REPORTS

Volume 9, Number 4, April 1968

In August 1959, the President directed the Secretary of Health, Education, and Welfare, to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels such as natural background, radiography, medical and industrial uses of isotopes and X rays, and fallout. The Department delegated this responsibility to the National Center for Radiological Health, Public Health Service.

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Reports

Summary of Iron-55 Contamination in the Environment and Levels in Humans

Warren A. Brill [1]

Levels of iron–55 in the environment and in food sources have been summarized. The average body burdens and resulting doses to the erythrocytes (red blood cells) of selected Alaskan Eskimos, and residents of the States of Washington, New York, and New Jersey are compared. Considering the erythrocytes as the critical organ, the dose rate from 1 pCi iron–55/mg stable iron is 0.095 mrad/yr. A body burden of 8 nCi, the average for Richland, Wash. residents, yields a yearly dose of 0.19 mrad, while 1,100 nCi, the average body burden for Eskimos on fish diets, yields a yearly dose of 26 mrad.

The objective of this paper is to summarize the data on levels of iron–55 in the environment and to review the dosimetric considerations of internally deposited iron–55. This radionuclide enters the environment primarily as a result of activation of iron–54 in thermonuclear devices tested in the atmosphere. It decays by electron capture (with a physical half-life of 2.4 years) to manganese–55. The only easily detectable radiation is a 5.9 keV X ray emitted with 28 percent of the disintegrations. Although both scintillation and proportional counting techniques have been used for quantitative determination, the sensitivity of either method depends upon the detector size and sample geometry (*1,2*). After suitable sample preparation, the detection limit of an electrodeposited sample is 6 to 8 pCi at 99-percent confidence level with a 60–100 minute count (*3–5*).

Environmental and human exposure levels

Iron–55 has been routinely sampled in precipitation by the Atomic Energy Commission's Health and Safety Laboratory (HASL) at several locations (*6*). In all cases, the levels of iron–55 have been corrected for decay by HASL to October 15, 1961. Environmental levels of iron–55 peaked in 1963–64 and have been decreasing since. Figures 1 through 6 show the

Table 1. Iron-55 in precipitation [a]
(mCi/km²)

Year	Westwood, N. J.	Appleton, Wisc.	Chattanooga, Tenn.	Oklahoma City, Okla.	Palo Alto, Calif.	Seattle, Wash.
1962	[b] (7–12) 28.70					
1963	(1–12) 248.81	(8–12) 41.42	(8–12) 18.25	(7–12) 31.33	(7–12) 3.27	(7–12) 39.70
1964	(1–12) 107.57	(1–12) 115.83	(1–12) 160.57	(1–12) 82.51	(1–12) 27.30	(1–12) 75.77
1965	(1–12) 47.74	(1–12) 44.94	(1–12) 47.56	(1–12) 54.12	(1–12) 26.75	(1–12) 39.50
1966	(1–12) 17.93					(1–12) 23.33
1967	(1–8) 1.91					(1) 1.22

[a] Decay corrected to 10/15/61. See reference *6*.
[b] Parentheses indicate chronological months of sampling.

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[1] Mr. Brill is staff officer, Radiation Exposure Intelligence Section, Standards and Intelligence Branch, and technical editor, *RHD&R*, National Center for Radiological Health, Rockville, Md. 20852.

pattern of fallout and precipitation for the HASL stations. Iron–55 levels in monthly precipitation approximately follow the precipitation pattern. The amount of iron–55 (decay corrected back to October 15, 1961) appears to have reached or be reaching a plateau (figure 7) for most of the stations. This means that the rate of atmospheric clearance of iron–55 is reaching its limiting value and that environmental levels will then show a net decrease with time. When the deposition is corrected for radioactive decay (figure 8), it is seen that the total accumulated deposition is actually decreasing at the present time. The data are most complete for the Westwood, N.J. station and a semilog plot of the yearly deposition shows an expotential decrease with a half-time of 10 months (figure 9). This exponential decrease is open to many interpretations but may be due solely to meteorological considerations (cf. 7).

In 1965 the first study of iron–55 in human, animal and plant populations was published by Palmer and Beasley (*4*). The content of iron–55 in various foods was related to the body burdens of certain animals and humans in the States of Washington and Alaska. These levels of iron–55 in foods and in humans are given in tables 2 and 3, respectively. As can be seen, Anaktuvuk Eskimos had an average body burden of 61 nCi in January 1965, 7.6 times the average burden reported for Richland, Wash. residents. Using data of Wrenn and Cohen, the average iron–55 body burdens of selected New York and New Jersey adult males and females for 1965–1966 is calculated to be 13.3 nCi (10.6 for males and 16.5 for females), also much lower than Alaskan Eskimos (*8*).

The Alaskan iron–55 food chain described by Palmer and Beasley was that of lichen-caribou-man, which is the same route as for cesium–137 (*4*). Iron–55 reaches vegetation primarily via air and precipitation deposition (*4*). Iron is also taken up by the roots, but a very small percentage reaches the vegetation via root uptake because of isotopic dilution of the radioiron by the stable iron in the soil (*9*). For example, whole wheat flour from various sources has been found to contain ten times as much iron–55 as bleached white flour, suggesting that the iron–55 is probably deposited on the outer shell of the wheat (*4*).

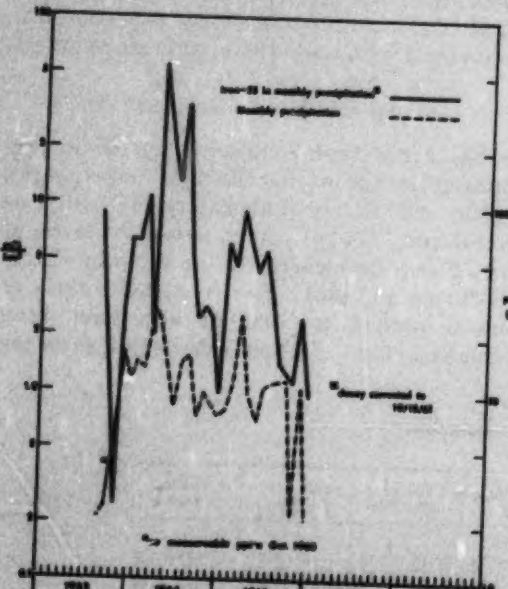

Figure 1. Iron–55 in monthly precipitation, Chattanooga, Tenn.

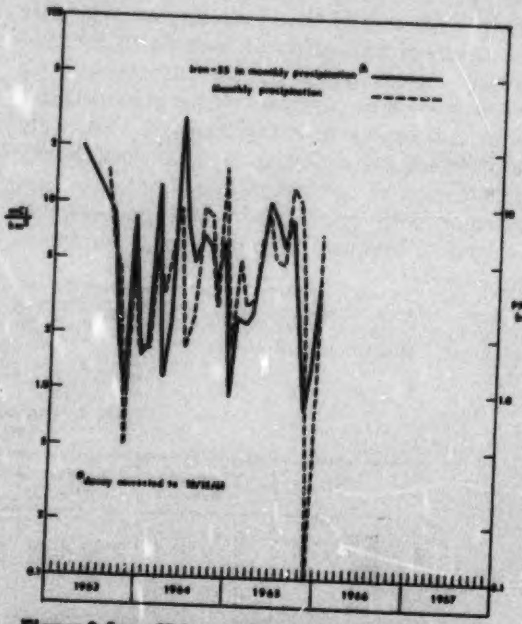

Figure 2. Iron–55 in monthly precipitation, Oklahoma City, Okla.

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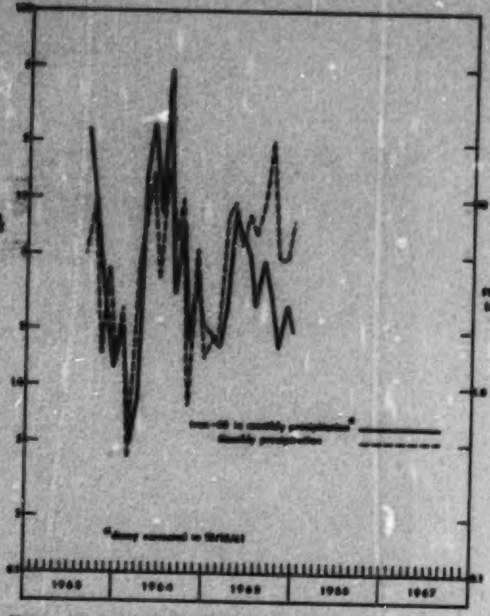

Figure 3. Iron-55 in monthly precipitation, Appleton, Wis.

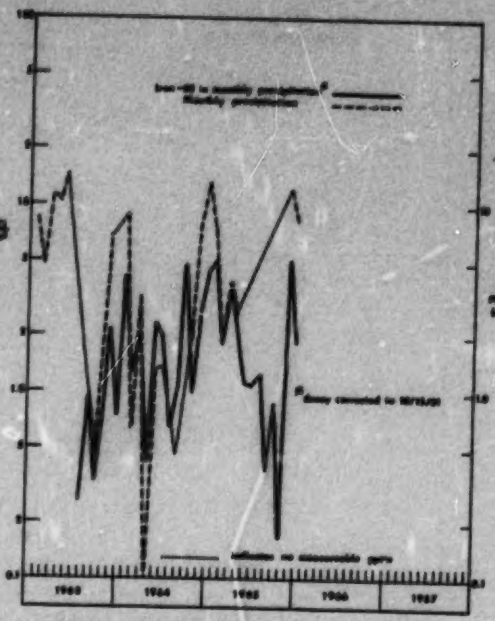

Figure 4. Iron-55 in monthly precipitation, Palo Alto, Calif.

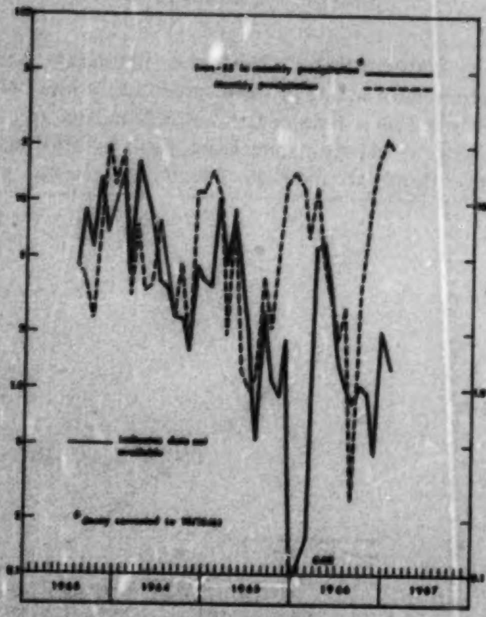

Figure 5. Iron-55 in monthly precipitation, Seattle, Wash.

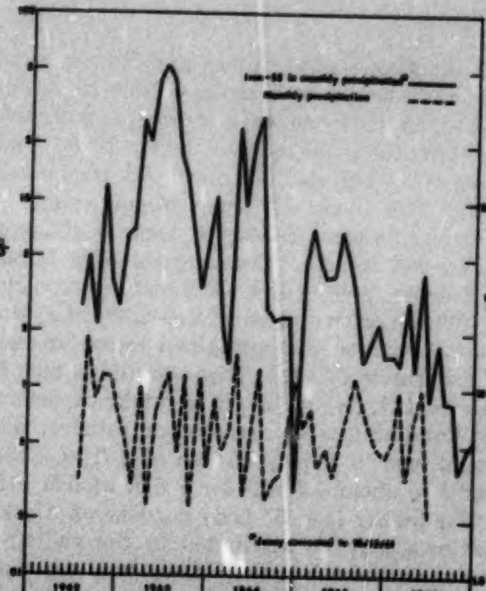

Figure 6. Iron-55 in monthly precipitation, Westwood, N.J.

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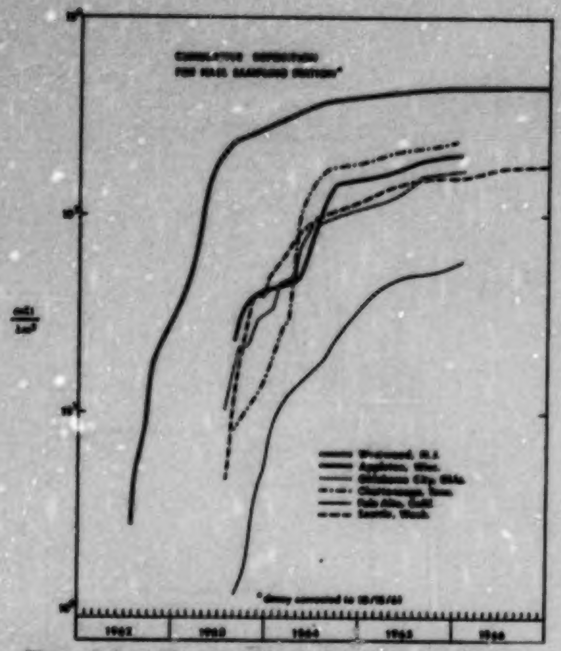

Figure 7. Iron–55 in monthly precipitation, cumulative deposition for HASL sampling stations from date of first reported sample

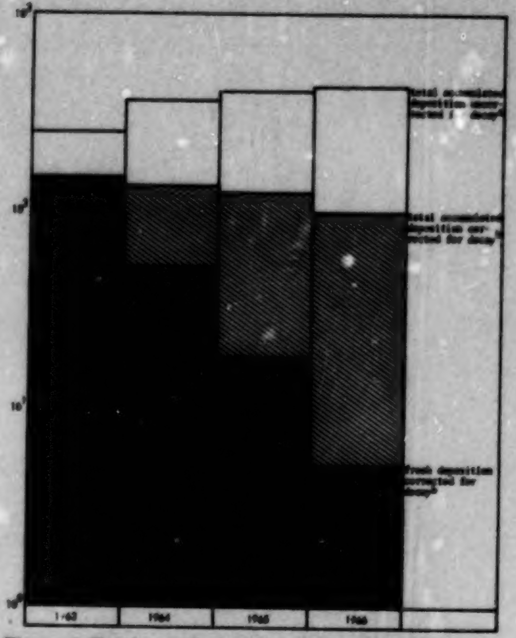

Figure 8. Total cumulative deposition of iron–55 in monthly precipitation at Westwood, N.J.
ᵃData from reference 6 uncorrected for decay normalized to October 15, 1961 (cf. figures 6 and 7)
ᵇData from reference 6 corrected for decay to October 15 of sampling year

In another study, Palmer and Beasley found that the marine food chain is able to concentrate iron–55 to an even greater extent, with levels in tuna and salmon being 20–30 times those of caribou and 100 times U.S. beef muscle (*10*). The livers of some salmon caught at Kotzebue, Alaska, contained about 2 μCi iron–55/kg wet weight. The average body burden of Eskimos primarily on fish diets were higher (1,100 nCi, with a range of 212–2,300 nCi) than Eskimos whose diet contained lesser amounts of fish (table 4) (*11*). The opposite is true for cesium–137, *i.e.*, the average intake of cesium–137 for Eskimos on caribou and reindeer diets would lead to a body burden of 3–5 nCi, compared to about 0.3 nCi for a diet of fish (*12*).

The higher iron–55 body burdens of Alaskan Eskimos may be attributed to the radioiron-contaminated fish in their diets; however, there is also a large percentage of iron-deficient individuals among the Eskimos (*9*). Furthermore, females have a higher turnover rate of iron due to menstrual blood loss and normally have higher body burdens than males; this has been advanced as a reason for sex distinction (*9*).

Several explanations exist for the high concentrations of iron–55 found in marine or-

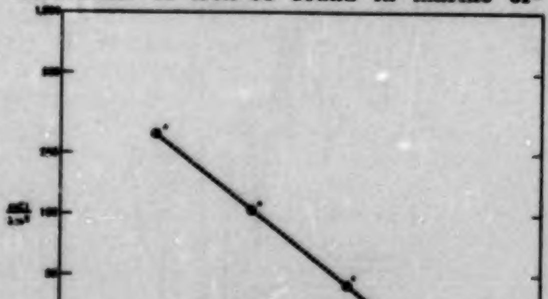

Figure 9. Iron–55 in yearly precipitation, Westwood, N.J.

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Table 2. Content of iron-55 in various foods purchased in December 1964 (*5*)

Food	Content	
	Stable iron (mg/kg)	Iron-55 (nCi/kg)
Alaskan caribou:		
Round steak	52	3.6
Round steak	43	2.9
Liver	308.8	28.7
Washington State meats:		
Beef, round steak	22	0.56
Beef, round steak	25	.02
Beef, round steak	21	.20
Beef liver	58	.85
Beef liver	46	1.2
Elk, lean	30	1.7
Elk, lean	37	1.8
Bologna	9.1	.34
Pork and ham loaf	16	.06
Pork chops	6.7	.018
Hamburger	27	.25
Weiners	12	.21
Pacific seafoods:		
[illegible]	8.1	7.47
Salmon	5.0	3.42
Tuna	6.9	6.42
Tuna	2.8	5.19
Cod	2.1	0.24
Clams	17.7	.045
Oysters	170	.067
Oysters (Atlantic)	98	.057
General:		
Whole-wheat flour	29	0.31
Whole-wheat flour	40	.27
Bleached white flour	30	.065
Bleached white flour	31	.036
Bleached white flour	32	.049
Bleached white flour	31	.026
Wheat flakes	50	.22
40% bran flakes	46	.37
Quaker oats	41	.15
Eggs	25	.54
Eggs	30	.055
Eggs	23	.16
Lettuce	4.8	.011
Carrots	4.1	.028

ganisms. Sea water contains only 10 μg stable iron/liter, therefore, the radionuclide is not isotopically diluted to the same extent as on land (*4*). In addition, most of the marine species of concern are fast growing fish, have a lower content of iron than land animals and probably take up and retain most of the iron–55 that is ingested and absorbed (*10*). An explanation offered is that the iron–55 is in a chemical form more readily available to fast growing fish (*e.g.*, salmon) than stable iron. The specific activity of iron–55 in salmon is about 10^3 to 10^4 times higher than that of particulates less than 0.3 microns in diameter filtered from sea water (*13*).

Although the rate of deposition of iron–55 has been decreasing (table 1 and figures 7 through 9), amounts in humans have been increasing because of the time lag due to nonequilibrium conditions. With the continued cessation of high yield atmospheric tests of thermonuclear devices and after radioactive equilibrium has been reached between the rate of buildup and the rate of decay in environmental and food sources, the amounts of iron–55 in man will decrease. The precise calculation of this time period is difficult, however, because the following parameters are unkown:

a. rate of fallout of iron–55 at the location in question;
b. effective half-life of iron–55 deposited on the lichen (for people on caribou diets);
c. effective half-life in the land and/or marine food sources; and
d. effective half-life of iron–55 in man as derived from these sources.

Table 3. Iron-55 in humans (*4*)

Subject	Date sampled	Number of subjects	Estimated total blood volume (liter)	Blood concentration (nCi/liter)	Total body burden (nCi)	
					Average	Range
Anaktuvuk Eskimos	1/65	7	5	7.3	61	33–99
Richland, Wash. residents	11/64	4	5	0.96	8	4–16

Table 4. Iron-55 body burdens associated with diets of Alaskan male Eskimos (*11*)

Diet	Average body burdens (nCi)
Fish	344
Fish and caribou	280
Caribou	80

Dosimetry

The International Commission on Radiological Protection (ICRP) recommends the spleen as the critical organ for iron–55 and sets the maximum permissible body burden (q) for the public at 100 μCi, which will result in a dose rate of 1.5 rad/yr to the critical organ (*14,15*).

Wrenn (*1*) and Wrenn and Cohen (*8*) have derived equations for calculation of dose to whole blood and erythrocytes (red blood cells). These are based upon the fact that iron accounts for 0.0057 percent of the body weight (*14*), with 60–75 percent of total body iron in the hemoglobin (*16*). In addition, the loss of iron from the hemoglobin is less than 0.1 percent per day (*16*). Upon transmutation and de-excitation, iron–55 and its daughter, manganese–55, principally emit a 5.9 keV X ray or a 5 keV auger electron. The latter has a range in water of 1 micron and will be absorbed within the 8 micron long by 2 micron thick erythrocyte. Because there are very short range radiations, it is more realistic to consider the erythrocytes rather than the whole blood when calculating doses from iron–55 (*1,8*). Wrenn analyzed samples from a blood bank, and since data were not available concerning sex and size, the total iron stores of each individual was estimated to be 4 grams. Utilizing the suggestion of Peacock, *et al.* (*17*), that all the energy of the X ray is deposited in the whole blood, Wrenn and Cohen calculated the dose due to the K-shell X rays from 1 pCi iron–55/mg stable iron as 0.282 µrad/week. This is probably an overestimate of whole blood dose because some of the energy of the X ray will be deposited in surrounding tissues. This calculation underestimates the dose to the erythrocytes because it does not take energy deposition by auger electrons into account. Since the mass of the erythrocytes constitute 47 percent of the mass of the total blood (*18*) and the ionization potential of the K-shell of manganese is 6.54 keV, the dose rate to the erythrocytes from 1 pCi iron–55/mg stable iron is composed of the dose rate due to X rays plus the dose rate due to auger electrons, as follows:

$$D = D_X + D_K + D_L$$

where, D = total dose rate,
D_X = dose rate due to K-shell X rays,
D_K = auger electron dose rate from K-shell capture, and
D_L = auger electron dose rate from L-shell capture.

The dose rate is then 1.83 µrads/week for 1pCi iron–55/mg stable iron. A continuous burden of 1 pCi iron–55/mg stable iron will result in a yearly dose of 0.095 mrad.

Palmer and Beasley used Wrenn's earlier method of dose calculation and determined that a constant total body burden of 1,000 nCi will produce an erythrocyte dose rate of "about 30 mrad/yr" (*1, 9*). A more precise estimate of the dose rate can be calculated if the fluorescence yield[2] of manganese–55 is taken into account (*9*); this would then be about 24 mrad/yr.

Recent investigators treat the erythrocytes as the critical organ, and it appears that the ICRP recommendation of the spleen as the critical organ for iron–55 should be re-evaluated. The calculated body burden of iron–55 considering the erythrocytes as the critical organ would then be:

$$\text{iron–55 body burden} = (A/B)\ (C)\ (D)$$

where, A = 1 pCi iron–55/mg stable iron in the body,
B = the dose rate that results from A (0.095 mrad/yr),
C = dose rate limits for members of the public for iron–55 (1.5×10^3 mrad/yr), and
D = average total body content of stable iron (4×10^3 mg).

Substituting the above numerical values, the calculated body burden for iron–55 is 63.2 µCi for the public. Wrenn and Cohen have suggested the bone marrow as the next tissue of concern, but more data is needed on uptake of iron–55 by marrow in humans and dosimetric evaluations (*8*).

Wrenn (*19*) has also proposed that the ferritin aggregates, which are present in liver, spleen, and reticulocytes and contain 20 percent iron by weight, may receive high locally delivered doses. It is estimated that the dose to ferritin aggregates is approximately 400 times that to the erythrocytes, although the total mass involved is considerably less than that of the erythrocytes.

Summary

Iron–55 is found in low levels in fallout deposition and food sources. For example, the total accumulated deposition at Seattle, Wash., from July 1963 to October 1966 was 176.01 mCi/km^2; iron–55 levels in Washington State meats varied from 0.013 nCi/kg for pork chops to 1.8 nCi/kg for lean elk meat. No data is available for iron-55 deposition in the State of Alaska, however, Alaskan caribou steak contained about 3 nCi/kg, caribou liver contained 28.7 nCi/kg and salmon liver almost 2 μCi/kg wet weight.

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[2] The probability that an atom whose electronic structure has been excited will emit an X-ray photon in the first transition, rather than an auger electron.

Ingestion of these and other contaminated foodstuffs resulted in the following body burdens and doses to the erythrocytes:

Population group	Average body burden (nCi)	Yearly dose to erythrocytes (mrad)
Richland Wash. residents–January 1965 (*4*)	8	0.19
Selected N. Y. and N. J. residents–1965–66 (*8*)	13.3	0.32
Anaktuvuk Eskimos–January 1965 (*4*)	61	1.4
Eskimos on fish diet (*10*)	1,100	26

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Data

SECTION I. MILK AND FOOD

In the determination of the internal exposure to man from environmental radiation sources, primary interest centers on radionuclides in the diet. Federal and State agencies are involved in efforts to monitor continuously the dietary intake of radionuclides. The most direct measure of radionuclide intake would be obtained through radioanalysis of the total diet. Difficulties in obtaining specific dietary data impede this approach. An alternate method entails the use of indicator foods to arrive at an estimate of the total dietary radionuclide intake.

Fresh milk is one such indicator food. It is consumed by a large segment of the U.S. population and contains most of the biologically significant radionuclides which appear in the diet. It also is one of the major sources of dietary intake for the short-lived radionuclides. For these reasons, fresh milk is the single food item often used in estimating the intake of selected radionuclides by the general population and/or specific population groups. In the absence of specific dietary information, it is possible to approximate the total daily dietary intake of selected radionuclides as being equivalent to the intake represented by the consumption of 1 liter of fresh milk.

The Federal Radiation Council (FRC) has developed Radiation Protection Guides (RPG's) for controlling normal peacetime nuclear operations, assuming continuous exposure from intake by the population at large (*1–3*). The RPG's do not and cannot establish a line which is safe on one side and unsafe on the other; they do provide an indication of when there is a need to initiate careful evaluation of exposure (*3*). Additional guidelines are provided by the FRC Protective Action Guides (*4*) and by the International Commission on Radiological Protection (*5, 6*).

Data from selected national, international, and State milk and food surveillance activities are presented herein. An effort has been made to present a cross-section of routine sampling programs which may be considered of a continuing nature. Routine milk sampling has been defined as one or more samples collected per month.

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(*1*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 13, 1960).

(*2*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1960).

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, protective action for strontium–89, strontium–90, and cesium–137, Report No. 7. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (July 1964).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 5. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1965).

(*5*) INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Recommendation of the International Commission on Radiological Protection, Report No. 2. Pergamon Press, New York, N.Y. (1959).

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National and International Milk Surveillance

As part of continuing efforts to quantitatively monitor man's exposure to radionuclides, various national and international organizations routinely monitor radionuclide levels in milk. In addition to those programs reported below, *Radiological Health Data and Reports* coverage includes:

Program	Period reported	Last presented
Radiostrontium in milk, HASL	July–December 1966	September 1967

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1. Pasteurized Milk Network
December 1967

National Center for Radiological Health and *National Center for Urban and Industrial Health, PHS*

The Public Health Service's Pasteurized Milk Network (PMN) is designed to provide nationwide surveillance of radionuclide concentrations in milk through sampling from major milk production and consumption areas. The present network of 63 stations (figure 1) provides data on milk in every State, Washington, D.C., the Canal Zone, and Puerto Rico. The

Table 1. Analytical errors associated with determinations of radionuclide concentrations in a milk sample

Nuclide	Concentration (pCi/liter)	Error [a] (pCi/liter)	Concentration (pCi/liter)	Error [a] (percent of concentration)
Strontium-89	< 50	5	≥ 50	10
Strontium-90	< 20	2	≥ 20	10
Iodine-131	<100	10	≥100	10
Cesium-137	<100	10	≥100	10
Barium-140	<100	10	≥100	10

[a] Two standard deviations.

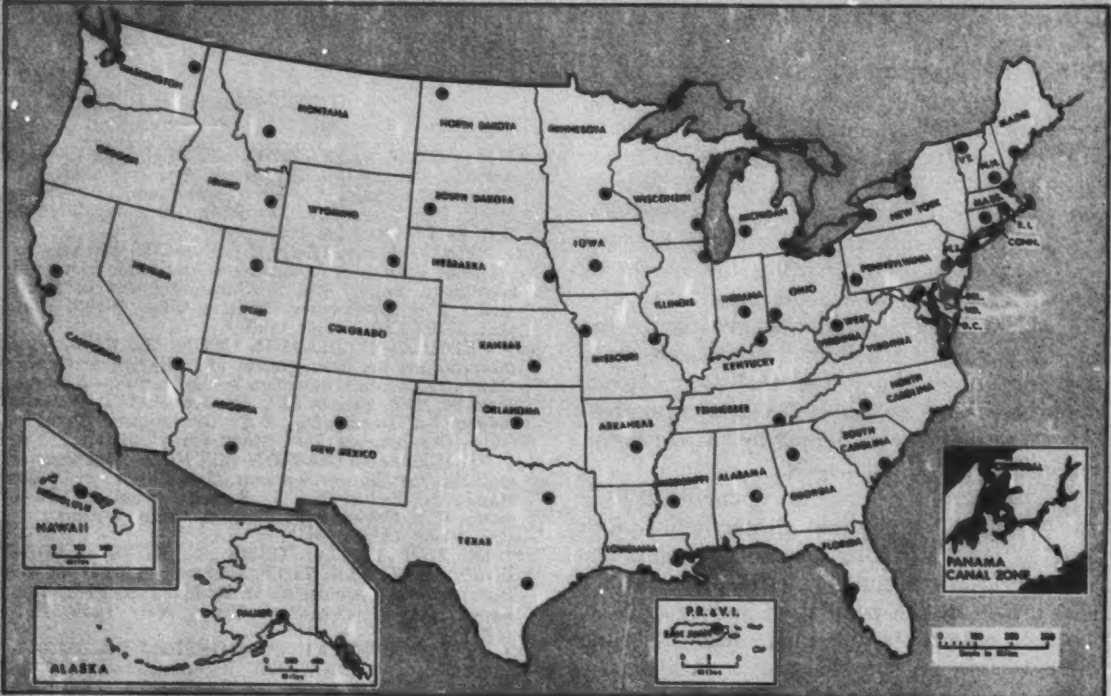
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
WISCONSIN
MICHIGAN
NEW YORK
VT.
N.H.
MAINE
MASS.
R.I.
CONN.
NEVADA
UTAH
COLORADO
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
CALIFORNIA
KANSAS
MISSOURI
KENTUCKY
WEST VIRGINIA
VIRGINIA
D.C.
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
MISSISSIPPI
ALABAMA
GEORGIA
TEXAS
LOUISIANA
FLORIDA
HAWAII
ALASKA
P.R. & V.I.
PANAMA CANAL ZONE

Figure 1. Pasteurized Milk Network sampling stations

Table 2. Average concentrations of radionuclides in milk for December 1967 and the 12-month period, January through December 1967[a]

Sampling location		Radionuclide concentration (pCi/liter)									
		Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
		Jan 1967–Dec 1967	Dec 1967	Jan 1967–Dec 1967	Dec 1967	Jan 1967–Dec 1967	Dec 1967	Jan 1967–Dec 1967	Dec 1967	Jan 1967–Dec 1967	Dec 1967
Ala:	Montgomery	0	0	10	10	2	0	15	7	0	0
Alaska:	Palmer	0	0	7	6	0	0	20	10	0	0
Ariz:	Phoenix	0	0	2	1	0	0	2	3	0	0
Ark:	Little Rock	0	0	22	20	1	0	30	18	0	0
Calif:	Sacramento	2	0	3	6	2	0	4	12	1	0
	San Francisco	2	0	3	1	1	0	2	7	0	0
C. Z:	Cristobal	0	0	4	3	0	0	30	7	0	0
Colo:	Denver	1	4	6	4	1	0	5	11	0	0
Conn:	Hartford	NA	NA	9	10	1	0	18	3	0	0
Del:	Wilmington	NA	NA	11	9	1	0	14	8	0	0
D. C:	Washington	0	0	10	9	0	0	10	8	0	0
Fla:	Tampa	0	0	8	7	1	0	75	64	0	0
Ga:	Atlanta	0	0	16	14	2	0	24	15	0	0
Hawaii:	Honolulu	0	0	4	4	2	0	9	7	2	0
Idaho:	Idaho Falls	1	2	6	5	0	0	8	6	0	2
Ill:	Chicago	0	0	9	8	0	0	14	15	0	0
Ind:	Indianapolis	[b]0	NA	9	8	0	0	10	7	0	0
Iowa:	Des Moines	1	0	8	8	0	0	7	11	1	2
Kans:	Wichita	1	0	8	9	0	0	4	3	0	0
Ky:	Louisville	1	0	13	10	0	0	8	0	1	0
La:	New Orleans	1	0	24	20	1	0	28	21	1	0
Maine:	Portland	0	NA	12	14	0	0	36	30	0	0
Md:	Baltimore	0	0	11	10	0	0	12	4	0	0
Mass:	Boston	0	0	12	11	0	0	31	30	0	0
Mich:	Detroit			9	8	1	0	15	9	0	0
	Grand Rapids	[b]0	NA	10	11	0	0	19	16	0	0
Minn:	Minneapolis	1	0	13	12	0	0	13	9	0	0
Miss:	Jackson	1	0	19	14	2	0	17	13	0	0
Mo:	Kansas City	2	2	9	7	1	0	3	3	1	0
	St. Louis	2	0	10	10	0	0	7	6	0	0
Mont:	Helena	1	0	6	6	0	0	9	11	0	0
Nebr:	Omaha	0	0	9	7	1	0	8	0	0	0
Nev:	Las Vegas	0	0	2	2	0	0	2	0	0	0
N. H:	Manchester	[b]0	NA	14	13	0	0	42	33	0	0
N. J:	Trenton	[b]0	NA	10	8	0	0	15	5	0	0
N. Mex:	Albuquerque	0	0	3	1	0	0	1	0	0	2
N. Y:	Buffalo	[b]0	NA	9	9	0	0	15	9	0	0
	New York	[b]0	NA	11	9	0	0	16	7	0	0
	Syracuse	[b]0	NA	[c]10	NA	[c]1	NA	[c]17	NA	[c]0	NA
N. C:	Charlotte	0	0	17	13	1	1	16	10	1	0
N. Dak:	Minot	3	3	14	12	0	0	13	13	0	0
Ohio:	Cincinnati	[b]0	NA	10	8	0	0	10	1	0	0
	Cleveland	[b]0	NA	10	9	0	0	14	12	0	0
Okla:	Oklahoma City	0	0	10	9	1	0	6	4	0	0
Oreg:	Portland	2	0	8	7	2	0	13	6	0	0
Pa:	Philadelphia	[b]0	NA	10	6	1	0	13	16	0	0
	Pittsburgh	NA	NA	13	11	1	0	20	14	0	0
P. R:	San Juan	1	0	5	5	0	0	14	5	0	0
R. I:	Providence	[b]0	NA	11	10	0	0	26	17	0	0
S. C:	Charleston	0	0	16	14	5	0	32	24	0	0
S. Dak:	Rapid City	2	0	12	10	1	0	12	7	1	2
Tenn:	Chattanooga	0	0	16	13	1	0	16	10	1	0
	Memphis	0	0	13	10	1	0	8	2	0	0
Tex:	Austin	0	0	4	4	3	0	4	7	0	0
	Dallas	0	0	9	7	2	0	7	0	0	0
Utah:	Salt Lake City	1	0	6	3	1	0	11	11	0	0
Va:	Norfolk	0	0	11	9	1	0	19	9	0	0
Vt:	Burlington	[b]0	NA	13	11	1	0	12	13	0	0
Wash:	Seattle	2	3	11	11	0	0	27	13	0	3
	Spokane	0	0	10	13	0	0	17	11	0	0
W. Va:	Charleston	0	0	12	10	0	0	8	6	0	0
Wis:	Milwaukee	NA	NA	7	7	0	0	15	10	0	0
Wyo:	Laramie	0	0	5	5	0	0	5	7	0	0
Network monthly average		0	0	10	9	1	0	15	11	0	0

[a] See text for averaging procedures.
[b] Based on only 1 month's data.
[c] Based on only 11 month's data.
NA, no analysis for the period reported.

most recent description of the sampling and analytical procedures employed by the PMN appeared in the January 1968 issue of *Radiological Health Data and Reports* (*1*). Reference should also be made to the February 1968 issue (*2*), in which several changes in the interpretation and reporting of data were introduced.

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Table 1 shows the approximate analytical errors (including counting error) associated with determinations of radionuclide concentrations in milk. These errors were determined by comparing results of a large number of replicate analyses. Table 2 contains averages for December 1967 and 12-month averages for the period January 1967 through December 1967. The 12-month averages facilitate evaluations of population exposure with respect to the guidance provided by the Federal Radiation Council, which suggests average total daily intakes averaged over periods of a year, as an appropriate criterion (*2*). The average radionuclide concentrations are based on results obtained from samples collected weekly. Whenever weekly concentrations were less than or equal to the appropriate minimum detectable levels, zero was used for averaging purposes (*2*). At very low radionuclide concentrations this often results in averages lower than the minimum detectable concentration of a single sample, but reflects that some of the samples making up the average were above detectable levels. The minimum detectable concentration is defined as the measured concentration equal to the two-standard deviation analytical error. Accordingly, the minimum detectable concentrations in units of pCi/liter are: strontium–89, 5; strontium–90, 2; iodine–131, cesium–137, and barium–140, 10. The average strontium–90 concentrations in pasteurized milk from selected cities are presented in figure 2.

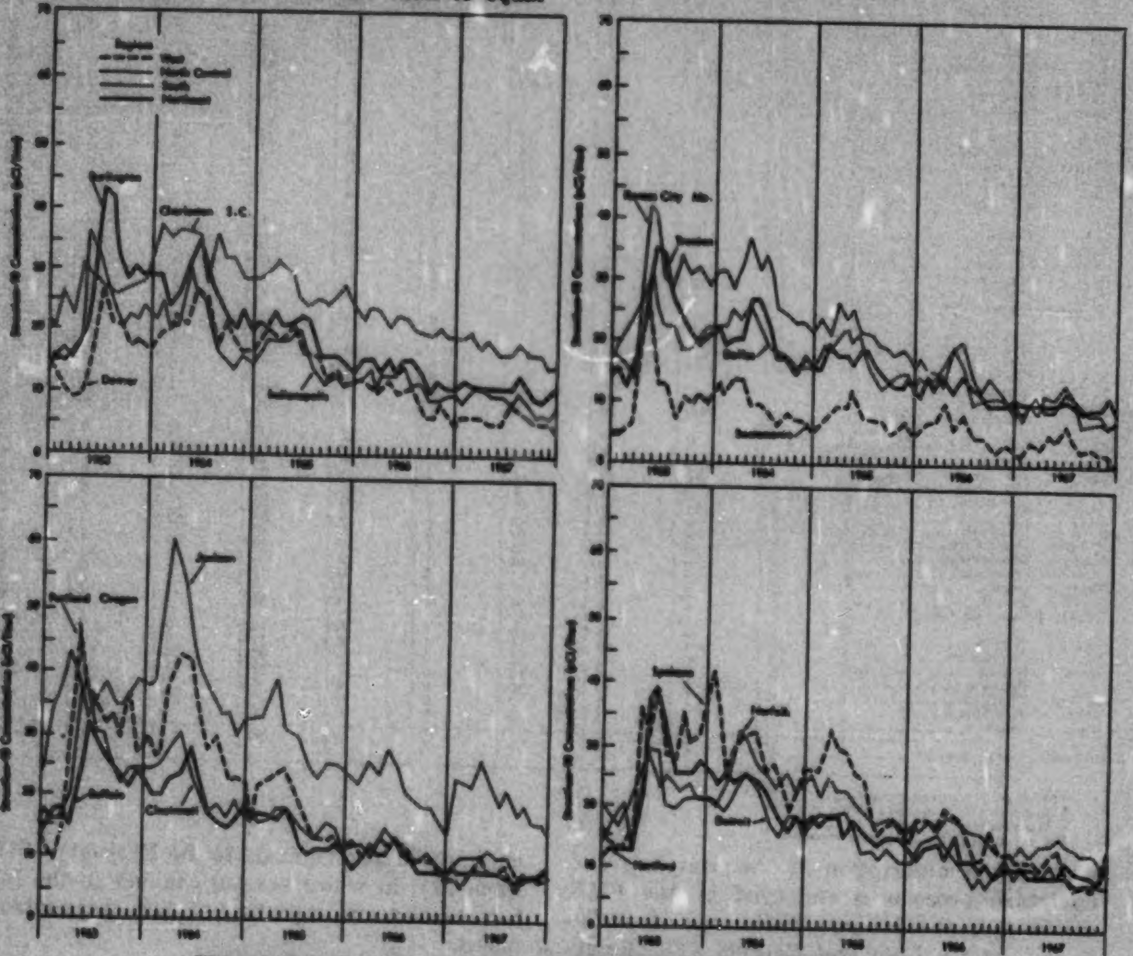

Figure 2. Strontium–90 concentrations in pasteurized milk, 1961–December 1967

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2. Canadian Milk Network December 1967[1]

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Department of National Health and Welfare began monitoring milk for strontium-90 in November 1955. In the beginning, analyses were carried out on samples of powdered milk obtained from processing plants. In January 1963, analysis of liquid whole milk was begun. This change allowed more representative samples of milk consumed to be obtained, and allowed the milk sampling locations (figure 3) to be chosen in the same areas as the air and precipitation stations. At present, the analyses include determinations of cesium-137 and strontium-90 as well as stable potassium and calcium.

The milk samples are obtained through the cooperation of the Marketing Division of the Canadian Department of Agriculture. At each station samples are collected three times a week from selected dairies, combined into weekly composites, and forwarded to the radiochemical laboratory in Ottawa. The contribution of each dairy to the composite sample is directly proportional to its volume of sales. In most cases a complete sample represents over 80 percent of the milk processed and distributed in the area. Several of the weekly samples are randomly selected and analyzed for iodine-131. The results of the spot checks for iodine-131 will not be reported unless there is evidence that the levels are rising. A monthly composite of the samples is analyzed for strontium-90, cesium-137 and stable potassium and calcium.

Analytical methods

Since it represents a more sensitive method, radiochemistry, rather than gamma spectrometry, is used to determine iodine-131 (*4*). For the analysis of radiostrontium, carrier strontium is added to a 1-liter sample of milk, and the milk is then placed in a tray lined with a polyethylene sheet and evaporated under infrared lamps. The residue is ashed in a muffle furnace at 450°C and dissolved in dilute nitric acid; strontium is separated by fuming nitric acid precipitation. The combined strontium-89 and strontium-90 are determined by counting in a low-background beta counter. Strontium-90 is determined separately by extracting and counting its yttrium-90 daughter, while strontium-89 is estimated by difference from the total radiostrontium measurement. Appropriate corrections are made for self-absorption and counter efficiency at all stages. Calcium is determined by flame photometry.

Cesium-137 is determined by gamma scintillation spectrometry using a scintillation crystal

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[1] Prepared from information and data in the January 1968 monthly report "Data from Radiation Protection Programs," Canadian Department of National Health and Welfare, Ottawa, Canada.

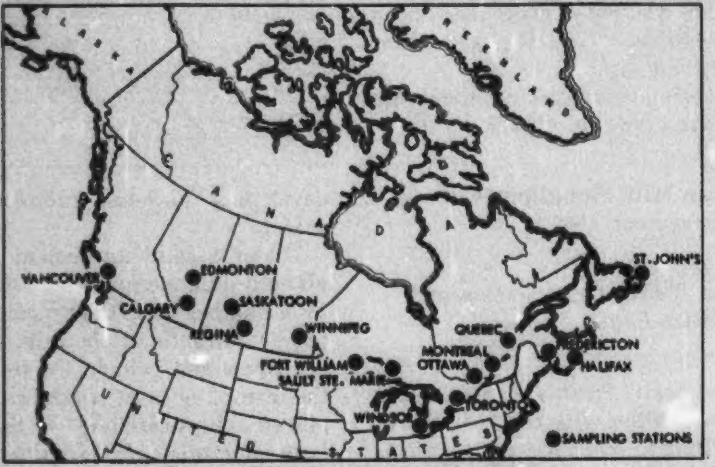

Figure 3. Canadian milk sampling stations

and multi-channel pulse height analyzer. A sample consisting of 4.5 liters of milk is placed in a sample tray constructed in the form of an inverted well to accommodate the 5- by 4-inch sodium iodide crystal detector. The sample is counted for 100 minutes and the gamma spectrum is then recorded. Estimates are made of the potassium–40 and cesium–137 content of the milk by comparison of the spectrum with the spectra of standard preparations of these two radionuclides. With this method the potassium–40 concentration is determined and the Compton contribution of this radionuclide to the cesium–137 photopeak is subtracted to obtain the cesium–137 concentration. The stable potassium content is estimated from the potassium–40 concentration.

Sources of error

In the iodine–131 and strontium–89 determinations, tests indicate that the statistical error (95-percent confidence level) in the chemical operations involved is about plus-or-minus 10 percent. This value is independent of the concentration of the radionuclide in the milk because it depends only on the recovery of the carrier. In the determination of cesium–137 this factor is not involved.

The chemical procedures error must be combined with the counting error which depends primarily on the concentration of the nuclide in the sample, the background radiation, and the length of time the sample and background are counted. This counting error has been evaluated mathematically for the particular counting arrangement used.

The overall errors, estimated on the basis indicated above, are given in table 5.

Table 5. Total error for various radionuclide concentrations in milk[a]

Nuclide	Error for 10 pCi/liter (percent)	Error for 50 pCi/liter (percent)	Error for 100 pCi/liter (percent)
Strontium-89	±25	±20	±15
Strontium-90	±15	±10	±10
Iodine-131	±50	±20	±10
Cesium-137	±60	±20	±10

[a] All errors are 2σ values, representing 95-percent confidence level.

Results

Table 6 presents monthly averages of strontium–90, cesium–137, and stable calcium and potassium in Canadian whole milk. Spot checks for iodine–131 and strontium–89 indicate that all samples had insignificant levels of these radionuclides.

The results show that radionuclide concentrations in Canadian whole milk remained well below the permissible levels.

Table 6. Stable elements and radionuclides in Canadian whole milk, December 1967

Station	Calcium (g/liter)	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Calgary	1.14	1.4	12	17
Edmonton	1.15	1.6	8	32
Ft. William	1.09	1.5	18	27
Fredericton	1.00	1.6	15	34
Halifax	1.15	1.6	12	26
Montreal	1.08	1.5	9	16
Ottawa	1.09	1.4	9	17
Quebec	1.06	1.5	13	28
Regina	1.02	1.5	7	8
St. John's, Nfld	1.14	1.4	17	20
Saskatoon	1.11	1.5	7	15
Sault Ste. Marie	1.14	1.6	16	23
Toronto	1.13	1.5	4	13
Vancouver	1.25	1.6	13	51
Windsor	1.17	1.6	4	14
Winnipeg	1.09	1.5	5	26
Average	1.12	1.5	11	22

3. Pan American Milk Sampling Program December 1967

Pan American Health Organization and
U.S. Public Health Service

The Pan American Health Organization (PAHO), in collaboration with the U.S. Public Health Service (PHS), furnishes assistance to health agencies in the American Republics in developing national radiological health programs.

Under a joint agreement between agencies, air and milk sampling activities are conducted by a number of PAHO member countries (figure 4). Results of the milk sampling program are presented below. Further information on the sampling and analytical procedures employed was presented in the December 1966 issue of *Radiological Health Data and Reports* (*5*).

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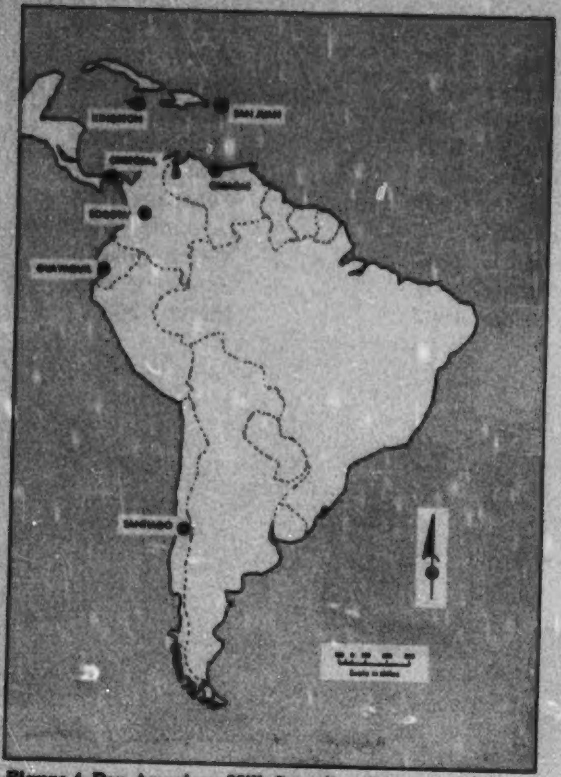

Figure 4. Pan American Milk Sampling Program stations

Table 7 presents stable potassium, strontium-90 and cesium-137 monthly concentrations for December 1967.

Table 7. Stable element and radionuclide concentration in PAHO milk,[a] December 1967

Sampling stations	Number of samples	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Chile: Santiago	1	1.5	<1	5
Colombia: Bogota	1	1.5	1	<5
Ecuador: Guayaquil	1	1.5	<1	<5
Jamaica: Montego Bay	1	1.5	8	330
Venezuela: Caracas	[b] 1	1.4	2	5
	1	1.5	<1	10
Canal Zone: Cristobal [c]	4	1.5	2	12
Puerto Rico: San Juan [c]	3	1.6	5	6

[a] Strontium-89 was less than 5 pCi/liter and iodine-131 and barium-140 were less than 10 pCi/liter for all samples.

[b] Sample for November 1967.

[c] For comparison purposes, the radionuclide concentrations at Cristobal, Canal Zone, and San Juan, Puerto Rico, from the Pasteurized Milk Network are presented.

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(2) PUBLIC HEALTH SERVICE. Pasteurized Milk Network, October 1967. Radiol Health Data Rep 9:86-89 (February 1968).
(3) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1960).
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State Milk Surveillance Activities

Considerable progress has been made by the State health departments in initiating or expanding environmental surveillance activities in radiological health. Many of the States now have comprehensive environmental surveillance programs and self-sustaining radiological health laboratories.

The continuing efforts of State health departments in the analysis and monitoring of radionuclides in milk complement Federal milk surveillance activities. State milk surveillance activities are continually undergoing developmental changes. The results presented herein are representative of current surveillance activities directed at the use of milk as an indicator of dietary intake of radioactivity.

Figure 1 shows the States which report milk surveillance activities in *Radiological Health Data and Reports*. States having programs appearing in this issue are highlighted in the figure. Following is a summary of previously covered State programs, their reporting period, and issue of appearance.

State milk network	Period reported	Last presented
California	July–September 1967	March 1968
Connecticut	July–September 1967	February 1968
Indiana	July–September 1967	February 1968
Iowa	July–September 1967	February 1968
Michigan	July–September 1967	February 1968
Minnesota	July–September 1967	February 1968
New York	April–June 1967	November 1967
Oregon	July–September 1967	March 1968
Pennsylvania	July–September 1967	February 1968
Washington	July–September 1967	March 1968

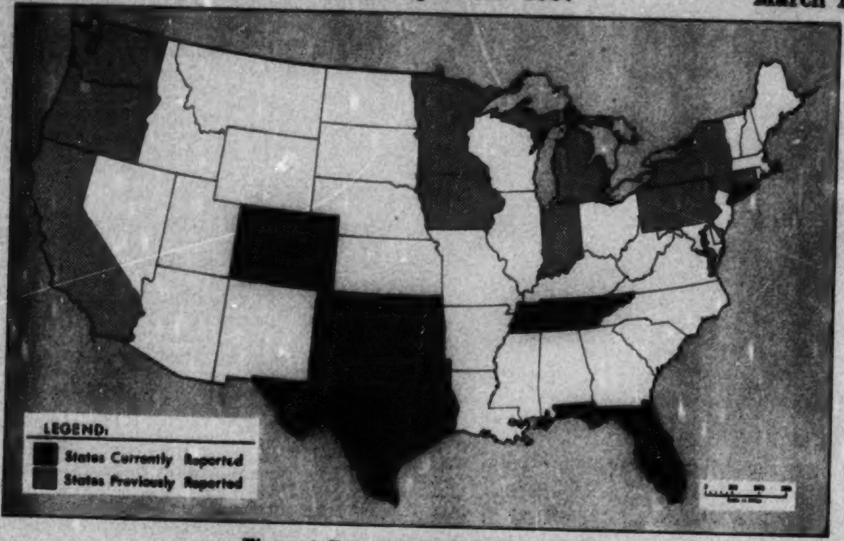

Figure 1. Reported State milk programs

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1. Colorado Milk Network
October–December 1967

Air, Occupational and Radiation
Hygiene Division
Colorado State Department of Public Health

The Radiation Hygiene Section of the Colorado State Health Department initated analysis of milk for gamma-ray emitting radionuclides in January 1962. Initially, a composite milk sample from the major producers supplying the Denver area was collected by the Denver City and County Health Department for the State.

In August 1962, the State expanded this program to include the sampling of raw milk from the major milk producing areas supplying the entire State. The routine sampling rate depends on the activities of the Milk, Food and Drug Section of the State Health Department. Milkshed areas are shown in figure 2.

Analyses are performed for iodine–131, barium-lanthanum–140, cesium–137 and potassium by gamma-ray spectrometry. Employed in this procedure is a 4 by 5-inch diameter NaI (Tl) crystal housed in a modified office safe lined with 2 inches of lead and a 512 multichannel pulse-height analyzer using a typewriter readout. Samples and backgrounds are counted for

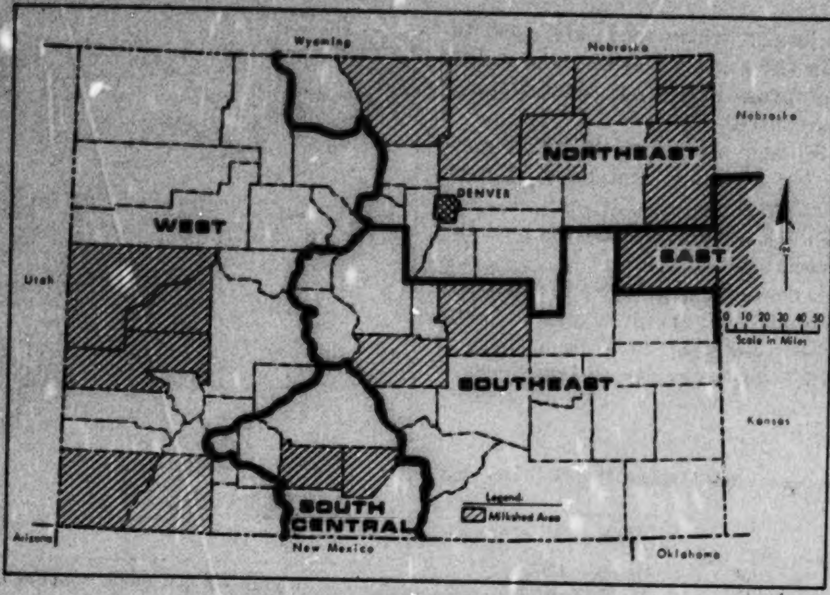

Figure 2. Colorado milk sampling stations

40 minutes in a 2 quart (1892 ml) plexiglass Marinelli beaker. Calculation is by the matrix method (*1*) and the minimum detectable concentrations are: iodine-131, 15 pCi/liter; barium-lanthanum-140, 21 pCi/liter; cesium-137, 16 pCi/liter; and potassium, 0.3 g/liter.

Eleven milk samples were collected and counted during the period from October 1, 1967, to December 31, 1967. Sampling was somewhat intensified in areas 3, 4, and 5, prior to and following the Gasbuggy shot of December 10, 1967. Iodine-131, barium-lanthanum-140 and cesium-137 were below the respective minimum detectable concentrations in all samples. Potassium concentration averaged 1.6 ± 0.3 (2σ) g/liter.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April-June 1967	October 1967
July-September 1967	January 1967

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2. Florida Milk Network
October-December 1967

Division of Radiological Health
Florida State Board of Health

The Florida State Board of Health began sampling raw milk for iodine-131 analysis in two major areas of the State in November 1962. The program has since been expanded to include the analysis of milk for strontium-89, strontium-90, cesium-137, barium-140 and potassium, in addition to iodine-131. Monthly samples are taken from randomly selected farms in each of the six regions shown in figure 3. A regional State Board of Health Laboratory is located in each of the six regions. Each laboratory prepares a monthly composite milk sample for its region by combining samples from 10 percent of the dairy farms selected at random. These composite samples are then sent to the State Radiological Health Laboratory in Orlando for analysis. In the interest of maintaining an active standby capability, samples are also collected and analyzed for iodine-131 on a monthly basis using the resin cartridge technique (*2*). Milk produced in the counties comprising each area is generally processed, marketed, and consumed in that area. These areas are characterized by differences in dairying practices related to the gradual transition from small farms in the west Florida region, where locally grown feeds are used, to larger farms in the southern areas, where different types of grass and predominately purchased feeds are used.

Strontium-89 and strontium-90 are determined by the ion exchange method developed by Porter *et al.* (*4*). Iodine-131, cesium-137, barium-140 and potassium are determined by gamma-ray spectrometry (*4*).

Radionuclide concentration levels for October through December 1967, are presented in table 1. Strontium-89 analyses have been discontinued since 1965 due to extremely low levels.

Recent coverage in *Radiological Health Data and Reports*:

Period	Issue
January–June 1967 and summary for 1966	October 1967
July–September 1967	January 1968

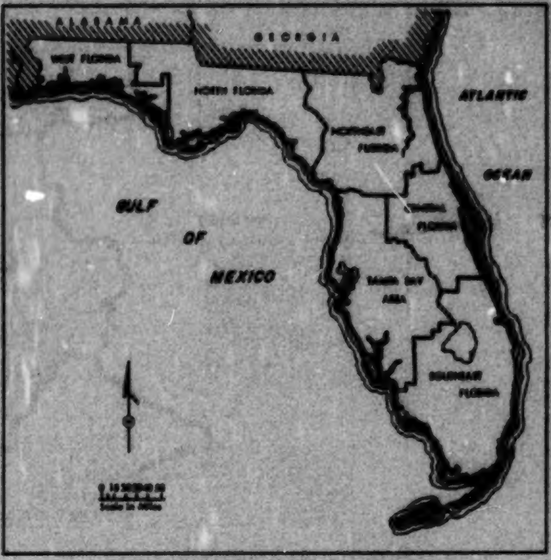

Figure 2. Florida milk sampling areas

Table 1. Stable element and radionuclide concentrations in Florida raw milk
October–December 1967

Sampling location	Concentration (g/liter)			Radionuclide concentration (pCi/liter)											
	Potassium			Strontium-90			Iodine-131			Cesium-137			Barium-140		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
West	1.6	1.5	1.2	16	18	12	ND	ND	ND	23	26	36	21	ND	ND
North	1.7	1.3	1.5	16	21	15	ND	30	ND	60	45	25	25	ND	ND
Northeast	1.6	1.6	1.6	10	NA	10	ND	ND	ND	125	84	88	24	ND	24
Central	1.7	(a)	(a)	9	9	(a)	ND	(a)	(a)	109	(a)	(a)	ND	(a)	(a)
Tampa Bay area	1.5	1.4	1.4	7	11	7	ND	ND	ND	104	101	79	21	24	ND
Southeast	1.4	1.4	1.4	9	7	9	ND	ND	24	108	114	90	ND	ND	24

a Insufficient sample.
ND, nondetectable.

3. Oklahoma Milk Network
October–December 1967

Oklahoma State Department of Health[1]

On March 15, 1965, the Radiological Health Section of the Oklahoma State Department of Health initiated a program of analysis for iodine-131 in the milk produced in the State of Oklahoma. On March 7, 1966, analysis for cesium-137 was added to the program.

The location of the sampling stations and the extent of their associated milksheds are shown in figure 3. Of the ten milksheds in the State of Oklahoma, five were chosen as sampling stations (Oklahoma City, Enid, Tulsa, Lawton, and Ardmore) on the basis of their size and location. A major criterion in the selection of a milkshed for sampling was the degree of overlap with other milksheds being sampled.

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[1] Acknowledgement is accorded to the staff of the Radiological Health Section under the direction of Mr. Dale McHard, head, and Mr. Robert Craig, assistant engineer.

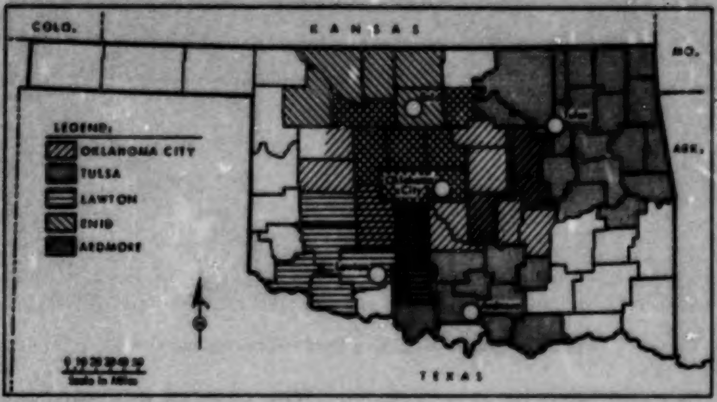

Figure 4. Oklahoma milkshed sampling areas

This overlap assists in locating small areas of production where the concentration of radioactivity might be abnormally high.

The sampling stations are located in the laboratory of a major milk-processing plant in each milkshed. While the milkshed for a particular processing plant may not coincide exactly with that shown in figure 3, the coincidence is satisfactory for surveillance purposes.

Analytical method

The method of analysis is similar to that recently published by the U.S. Public Health Service (*5*) but was developed independently by the Oklahoma State Health Department's Radiological Health Laboratory and has not been published to date. Details of the procedure used were published earlier (*6*).

Table 2. Concentration of cesium-137 in Oklahoma pasteurized milk, October-November 1967

Sampling date	Concentration (pCi/liter)				
	Sampling location				
	Oklahoma City	Enid	Tulsa	Lawton	Ardmore
1967					
October 16	16	ND	16	ND	14
October 20	ND	15	ND	ND	12
October 27	ND	ND	ND	ND	ND
November 13	ND	ND	ND	ND	ND
November 20	11	ND	10	ND	ND

ND, nondetectable.

Results and discussion

The concentrations of iodine-131 found in Oklahoma milk were less than the minimum detectable concentration of 3 pCi/liter. Cesium-137 concentrations are presented in table 2. The minimum detectable concentration for cesium-137 is 10 pCi/liter.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April-June 1967	October 1967
July-September 1967	January 1968

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4. Tennessee Milk Network October-December 1967

Division of Preventable Diseases Department of Public Health, State of Tennessee

The Tennessee Department of Public Health began sampling pasteurized milk for radionuclide analysis in July of 1965. Currently the Department is collecting semimonthly milk samples from three cities (figure 4). In order to obtain a representative sample of the milk consumed in the areas monitored, a sample of

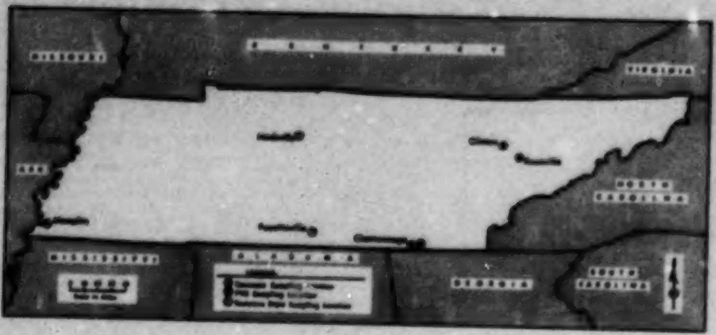


Figure 5. Tennessee pasteurized milk sampling areas

milk is collected from each distributor supplying the city. The samples from the individual distributors are then composited in proportion to the contribution each makes to the total city milk supply.

Analytical procedures

The semimonthly milk samples from each city sampled are analyzed by gamma-ray scintillation spectrometry for iodine-131, cesium-137, and barium-140, using a 3½-liter sample (7). After gamma-ray analysis, the samples are stored for 2 weeks to allow in-growth of daughter radioactivity, after which strontium-89, strontium-90, and barium-140 concentrations are determined radiochemically using ion-exchange procedures. Chemical analyses are also made for stable potassium.

The Chattanooga milk sample is monitored by both the State and the Public Health Service's Southeastern Radiological Health Laboratory. This dual examination of aliquot samples provides a crosscheck between the two laboratories.

Results

The monthly average stable element and radionuclide concentrations in Tennessee pasteurized milk are presented in table 3 for the period of October through December 1967.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	October 1967
July–September 1967	January 1968

Table 3. Radionuclides in Tennessee pasteurized milk, October–December 1967

Location	Month 1967	Concentration (g/liter)	Radionuclide concentration (pCi/liter)				
		Potassium	Strontium-89	Strontium-90	Iodine-131	Cesium-137	Barium-140
Chattanooga	Oct	1.4	7	18	<5	15	<5
	Nov	1.4	<5	14	<5	14	<5
	Dec	1.4	<5	10	<5	14	<5
Clinton	Oct	NS	NS	NS	NS	NS	NS
	Nov	NS	NS	NS	NS	NS	NS
	Dec	1.4	<5	13	19	20	<5
Knoxville	Oct	1.3	<5	16	<5	8	<5
	Nov	1.3	7	15	<5	9	<5
	Dec	1.5	<5	14	<5	20	<5

NS, no sample collected.

5. Texas Milk Network October–December 1967

Texas State Department of Health[5]

The Texas State Department of Health initiated a Statewide milk sampling network for radionuclide content in April 1964. At present, monthly samples of raw milk are collected from each of seven "active" sampling points. In addition, six "standby" stations are collecting raw milk samples once each calendar quarter. The station locations shown in figure 5 were chosen to give maximum geographical and population coverage.

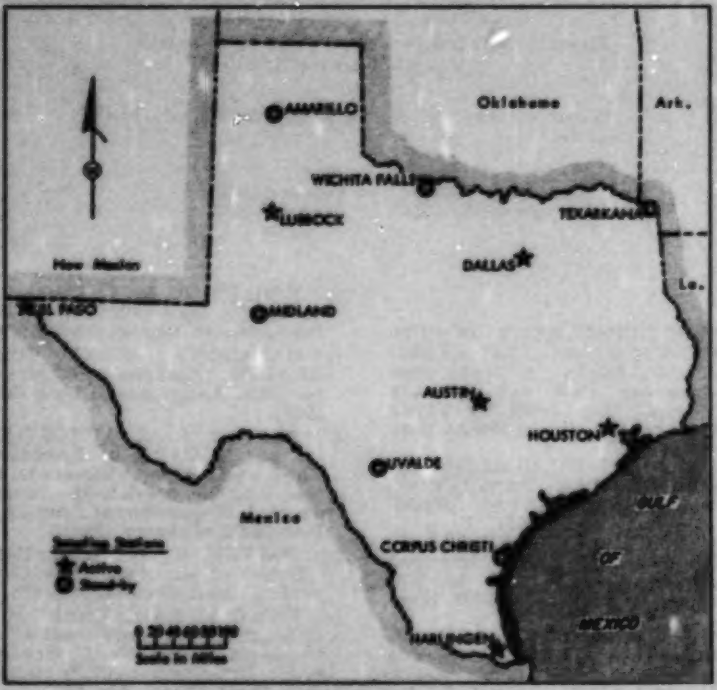
Samples are routinely analyzed for strontium–90 by a chemical separation technique employing ion exchange columns (*8*). Prepared samples are counted for 100 minutes in a low-background beta-particle counter.

Potassium–40, iodine–131, barium–140 and cesium–137 concentrations are determined by gamma-ray spectrometry. The procedure employs a 4- by 4-inch sodium iodide crystal and a 400-channel analyzer. Samples are counted for 100 minutes in a 3.5 liter Marinelli beaker. The matrix method of calculation is used and detection limits at the 95-percent confidence level are 10 pCi/liter.

Results

Potassium–40, strontium–90 and cesium–137 results by station and month for October through December 1967 are presented in table 4. During this time, the iodine–131, and barium–140 concentrations were below their limits of detectability (10 pCi/liter). A summary of radionuclide concentrations in Texas milk for the period from April 1964 through December 1967 is presented in figure 6.

Comparison of the observed radionuclide concentrations with the Federal Radiation Council guides for peacetime operation indicates that at no time during the period of surveillance did the radionuclide concentrations in Texas milk approach levels suggesting any remedial action (*9*).



Oklahoma
Ark.
AMARILLO
WICHITA FALLS
LUBBOCK
TEXARKANA
New Mexico
DALLAS
La.
EL PASO
MIDLAND
AUSTIN
HOUSTON
UVALDE
Mexico
GULF
OF
MEXICO
Sampling Stations
Active
Stand-by
CORPUS CHRISTI
HARLINGEN
0 20 40 60 80 100
Scale in Miles

Figure 5. Texas milk sampling stations

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[5] Acknowledgment is accorded to the staff of the Radiation Control Program, Division of Occupational Health and Radiation Control, under the direction of Mr. Martin C. Wukasch, chief engineer.

Table 4. Radionuclide concentrations in Texas raw milk network October–December 1967

Sampling location	Radionuclide concentration (pCi/liter)								
	Potassium-40			Strontium-90			Cesium-137		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
Austin a									
Fort Worth	[illegible]	[illegible]	[illegible]	5	5	4	[illegible]	10	5
El Paso	[illegible]	[illegible]	[illegible]	1	1	2	[illegible]	[illegible]	5
Harlingen	[illegible]	[illegible]	[illegible]	2	[illegible]	2	[illegible]	[illegible]	[illegible]
Houston	[illegible]	[illegible]	[illegible]	12	[illegible]	11	[illegible]	[illegible]	[illegible]
Lubbock	[illegible]	[illegible]	[illegible]	3	[illegible]	4	[illegible]	[illegible]	[illegible]
San Antonio	1,370	1,320	[illegible]	3	2	6	5	[illegible]	[illegible]
Average	1,310	1,310	1,300	4	3	4	5	5	5

a Austin, Tex., discontinued sampling October 1, 1967.

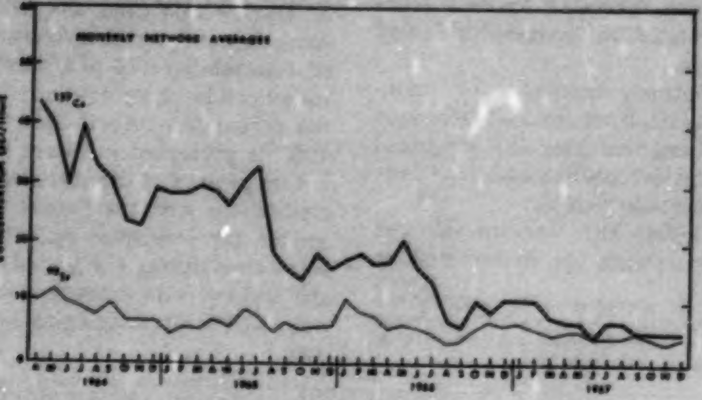

Figure 7. Radionuclide concentrations in Texas milk, April 1964–December 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	October 1967
July–September 1967	January 1968

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(2) INDIANA STATE BOARD OF HEALTH, BUREAU OF ENVIRONMENTAL SANITATION. Indiana milk network, April–June 1965. Radiol Health Data 6:612–614 (November 1965).

(3) PORTER, C., D. CAHILL, R. SCHNEIDER, P. ROBBINS, W. PERRY, and B. KAHN. Improved determination of strontium-90 in milk by ion-exchange method. Anal Chem 33:1306–1308 (September 1961).

(4) FLORIDA STATE BOARD OF HEALTH, DIVISION OF RADIOLOGICAL HEALTH. Florida milk network, July–December 1964. Radiol Health Data 6:611–612 (November 1965).

(5) PORTER, C. R., and M. W. CARTER. Field method for rapid collection of iodine-131 from milk. Public Health Rep 80:453–456 (May 1965).

(6) OKLAHOMA STATE DEPARTMENT OF HEALTH. Oklahoma milk network, October–December 1966. Radiol Health Data Rep 8:203–204 (April 1967).

(7) PORTER, C., R. AUGUSTINE, J. MATUSEK, Jr., and M. CARTER. Procedures for determining stable nuclides and elements in environmental samples, PHS No. 999–RH–10. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (January 1965).

(8) PORTER, C., and B. KAHN. Improved determination of strontium-90 in milk by ion exchange method. Anal Chem 36:676–678 (March 1964).

(9) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Periodically, results from the United Kingdom Diet survey conducted by the United Kingdom Agricultural Research Council Radiobiological Laboratory, are presented for comparison with data observed in the United States. Programs most recently reported in *Radiological Health Data and Reports* and not covered in this issue are as follows.

Program	Period reported	Last presented
California Diet Study	March–June 1967	February 1968
Connecticut Standard Diet	January–June 1967	November 1967
Tri-City Diet, HASL	January–March 1967	March 1968

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1. Radionuclides in Institutional Diet Samples

July–September 1967

National Center for Radiological Health
Public Health Service

The determination of radionuclide concentrations in the diet constitutes an important element of an integrated program of environmental radiological surveillance and assessment. In recognition of the potential significance of the diet in contributing to total environmental radiation exposures, the Public Health Service initiated its Institutional Diet Sampling Program in 1961. This program is administered by the National Center for Radiological Health with the assistance of the National Center for Urban and Industrial Health (*1*).

The program was designed to provide estimates of the dietary intake of radionuclides in a selected population group ranging from children to young adults of school age. Initially, the program was conducted at eight institutions; as of January 1965, its scope had increased to boarding schools or institutions in 50 municipalities. These institutions ranged from financially well-to-do boarding schools to orphanages with severe economic limitations.

Subsequent experience with the diets of school children of various ages indicated that the number of institutions sampled could be selectively reduced. As of July 1965, 21 basic institutions, distributed geographically as shown in figure 1, were being sampled. Previous results show that the daily dietary intake

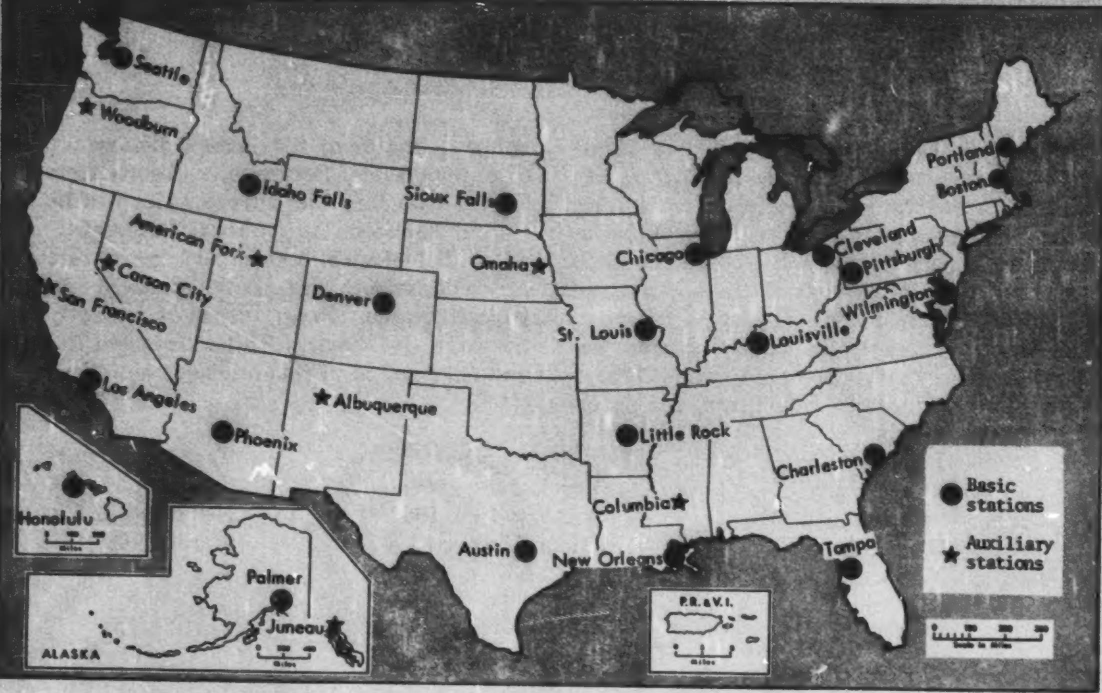
Seattle
Woodburn
Idaho Falls
Sioux Falls
American Fork
Omaha
Carson City
San Francisco
Denver
Chicago
Cleveland
Pittsburgh
Portland
Boston
Wilmington
St. Louis
Louisville
Los Angeles
Albuquerque
Phoenix
Little Rock
Charleston
Honolulu
Columbia
Austin
New Orleans
Tampa
Palmer
Juneau
ALASKA
P.R. & V.I.
Basic stations
Auxiliary stations

Figure 1. Institutional diet sampling locations as of September 1967

of teenage girls and children from 9 to 12 years of age were comparable, while teenage boys consumed 20 percent more food per day (*1*, *2*). Consequently, estimates for teenage boys and/or girls can be calculated on the basis of the dietary intakes of children.

In general, the sampling procedure is the same at each institution. Each sample supplied monthly by each institution represents the edible portion of the diet for a full 7-day week (21 meals plus soft drinks, candy bars, or other in-between snacks) obtained by duplicating the meals of a different individual each day. Drinking water not included in the samples, is also sampled periodically. Each daily sample is kept frozen until the end of the collection period, and is then packed in dry ice and shipped by air express to either the Southwestern Radiological Health Laboratory, Las Vegas, Nev., the Southeastern Radiological Health Laboratory, Montgomery, Ala., or the Northeastern Radiological Health Laboratory, Winchester, Mass. A detailed description of sampling and analytical procedures was presented earlier (*3*).

Results

Table 1 presents the analytical results for institutional diet samples collected from July through September 1967, for children 9 to 12 years of age. The stable elements, calcium and potassium, are reported in g/kg of diet, and the radionuclide concentrations of these samples, reported in pCi/kg of diet, are corrected for radioactive decay to the midpoint of the sample collection period, where applicable. Dietary intakes, in g/day or pCi/day, were obtained by multiplying the food consumption rate in kg/day by the appropriate concentration values. The average food consumption rate during this period was 1.84 kg/day compared to the network average of 1.90 kg/day observed from 1961 through 1964 (*4*).

Strontium-90 dietary intake during this period averaged 14 pCi/day. This result falls within Range I as defined by the Federal Radiation Council (*5*). Cesium-137 intakes averaged 28 pCi/day during this period. Strontium-89, barium-140 and iodine-131 concentrations were generally below detectable levels.

Table 1. Concentrations and intake of stable elements and radionuclides in institutional total diets in children (9-12 years of age), July-September 1967

Location of institution	Month	Total weight (kg/day)	Calcium		Potassium		Strontium-90		Cesium-137		Radium-226	
			g/kg	g/day	g/kg	g/day	pCi/kg	pCi/day	pCi/kg	pCi/day	pCi/kg	pCi/day
Alaska: Palmer	July	1.80	0.5	0.8	1.3	2.1	5	8	25	40	0.4	0.6
	Aug	1.62	.4	.6	1.2	1.9	5	8	20	32	.6	1.0
	Sept	1.54	.7	1.1	1.6	2.4	12	18	47	72	.7	1.1
Ariz: Phoenix	July	2.19	.8	1.8	1.6	3.6	4	8	15	32	.6	1.3
	Aug	2.07	.8	1.7	1.4	2.9	3	6	11	22	1.1	2.3
	Sept	1.93	.6	1.2	1.5	3.0	8	15	11	22	.6	1.3
Ark: Little Rock	July	1.28	.6	.7	1.7	2.1	20	25	15	19	.8	1.0
	Aug	1.70	.6	1.1	1.9	3.4	17	20	17	30	.7	1.2
	Sept	2.12	.6	1.3	1.9	4.1	15	32	28	49	.5	1.1
Calif: Los Angeles	July	2.08	.5	1.1	1.3	2.6	4	7	0	0	.4	.8
	Aug	1.88	.5	1.0	1.6	3.0	6	12	12	22	.6	1.3
	Sept	1.98	.5	.9	1.3	2.5	4	7	12	22	.6	1.1
Colo: Denver	July	2.90	.7	2.1	1.6	4.8	6	18	15	45	.7	2.1
	Aug	2.37	.6	1.5	1.6	3.7	6	13	13	31	.5	1.1
	Sept	2.35	.6	1.5	1.3	3.1	4	10	11	26	.8	1.9
Del: Wilmington	July	2.36	.8	1.9	1.8	4.3	16	14	17	40	[illegible]	1.9
	Aug	2.30	.7	1.5	1.9	4.1	9	20	14	31	.5	1.1
	Sept	2.22	.7	1.5	1.8	4.1	10	21	0	0	[illegible]	1.6
Fla: Tampa	July	1.94	.6	1.1	1.9	3.7	5	10	61	118	.7	1.4
	Aug [b]	2.06	.6	1.3	1.8	3.7	7	15	43	88	.8	1.6
	Sept [b]	2.00	.6	1.2	1.8	3.6	9	19	55	115	.9	1.9
Hawaii: Honolulu	July	2.05	.4	.9	1.6	3.2	0	0	0	0	.6	1.3
	Aug [b]	1.62	.4	.6	1.2	1.9	5	8	20	32	.6	1.0
	Sept [b]	1.91	.3	.5	1.3	2.6	4	7	18	25	.2	.4
Idaho: Idaho Falls	July [b]	1.87	1.4	2.6	1.7	3.1	6	11	12	22	1.7	3.2
	Aug [b]	2.05	1.2	2.5	2.0	4.1	14	30	26	53	.8	1.6
	Sept [b]	1.82	1.4	2.6	1.7	3.2	9	16	0	0	.4	.7
Ill: Chicago	July	1.33	.7	.9	1.6	2.2	7	9	22	29	.9	1.2
	Aug [b]	1.64	.6	1.2	1.6	2.6	8	13	18	30	.5	.8
	Sept [b]	1.63	.6	1.1	1.6	2.7	5	8	11	18	.7	1.1
Ky: Louisville	July	1.76	.8	1.4	1.6	2.8	8	14	0	0	.7	1.2
	Aug	1.73	.7	1.3	1.6	2.7	9	16	14	24	1.4	2.4
	Sept [b]	2.28	.5	1.1	1.6	3.6	7	15	0	0	.7	1.6
La: New Orleans	July	1.96	.6	1.3	1.7	3.3	11	22	25	49	.4	.8
	Aug	2.36	.7	1.7	1.6	3.6	12	27	22	50	.4	.9
	Sept	2.06	.8	1.6	1.7	3.5	13	26	26	54	.8	1.6
Mass: Boston	July	1.70	.7	1.2	1.6	2.8	11	19	32	54	.5	.8
	Aug	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Sept	2.08	.7	1.5	1.8	3.8	10	21	19	40	.7	1.5
Mo: St. Louis	July	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Aug	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Sept	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Ohio: Cleveland	July	1.43	.6	.8	2.0	2.8	8	11	0	0	.9	.7
	Aug	1.46	.6	.8	1.9	2.8	8	12	12	18	.9	1.3
	Sept	1.31	.7	.9	1.9	2.5	5	6	0	0	1.9	2.5
Pa: Pittsburgh	July [b]	2.20	.6	1.2	1.5	3.4	6	14	16	35	.7	1.5
	Aug	2.30	.6	1.3	1.6	3.6	7	16	0	0	.6	1.4
	Sept	2.25	.5	1.2	1.5	3.4	7	16	20	45	.6	1.4
S. C.: Charleston	July	1.61	.6	1.0	1.7	2.8	9	14	46	74	1.1	1.8
	Aug	1.54	.5	.8	1.5	2.3	8	12	26	43	1.3	2.0
	Sept [b]	2.00	.6	1.2	1.5	3.1	11	22	21	42	1.0	2.0
S. Dak: Sioux Falls	July	1.36	.7	1.0	1.7	2.0	7	9	0	0	.7	.9
	Aug	1.18	.7	.8	1.8	2.2	7	8	0	0	.9	1.1
	Sept	1.31	.6	.7	1.7	2.2	5	6	0	0	.2	.3
Tex: Austin	July	1.36	.6	1.0	1.5	2.9	3	6	0	0	.6	1.1
	Aug	1.53	.6	.9	1.3	2.0	8	12	0	0	1.4	2.1
	Sept	1.63	.6	.9	1.4	2.2	5	8	0	0	.6	1.0
Vt: Burlington [a]	July	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Aug	1.62	.8	.9	1.8	2.4	16	24	26	38	1.3	1.9
	Sept	1.40	.7	1.0	1.6	2.3	12	17	25	35	.7	1.0
Wash: Seattle	July [b]	1.92	NA	NA	1.8	3.3	NA	NA	18	34	NA	NA
	Aug [b]	2.23	.9	2.0	1.1	2.5	7	15	0	0	.3	.7
	Sept [b]	1.80	.6	1.0	1.3	2.5	6	12	20	28	.5	.9
Institutional average	July	1.83	0.6	1.2	1.6	3.0	7	12	17	31	0.7	1.2
	Aug	1.82	0.6	1.1	1.6	2.9	9	16	13	24	0.9	1.5
	Sept	1.87	0.6	1.2	1.6	3.0	8	16	15	28	0.7	1.3

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[a] Institution change in August 1967 from Burlington, Vt. to Portland, Maine.

[b] Since food samples were collected from two or more children who were not between the ages of 9 to 12, data for this month were not used in institutional average.

NA, no analysis.

NS, no sample.

NOTE: Since iodine-131 and barium-140 were not detectable at most stations during the third quarter 1967, no provision was made for these nuclides in the table. The few exceptions are as follows: barium-140 was reported in July for Washington, 14 pCi/kg; in August for Hawaii, 10 pCi/kg, and in September for Arizona, 18 pCi/kg.

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In past issues minimum detectable concentrations have been presented as less than values. Beginning with this issue all concentrations that are less than or equal to the appropriate minimum detectable level will be reported as zero. The minimum detectable concentration is defined as the measured concentration equal to the two-standard deviation analytical error. Accordingly, the minimum detectable limits are as follows:

Strontium-89	5 pCi/kg
Strontium-90	2 pCi/kg
Iodine-131	10 pCi/kg
Barium-140	10 pCi/kg
Cesium-137	10 pCi/kg
Radium-226	0.1 pCi/kg

Beginning with this issue, data from eight auxiliary stations will be included in a separate table for general information. This is presented in table 2. These stations do not meet the criteria that the majority of the children in the institution range in age from 9 to 12 years. In order to supplement the existing environmental monitoring networks of the National Center for Radiological Health, these eight institutions are also being sampled in the same manner as the basic stations.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
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April–June 1967	January 1968

Table 2. Concentrations and intake of stable elements and radionuclides in Institutional total diets of individuals, July–September 1967 (auxiliary stations)

Location of Institution		Month	Total weight (kg/day)	Calcium		Potassium		Strontium-90		Cesium-137		Radium-226	
				g/kg	g/day	g/kg	g/day	pCi/kg	pCi/day	pCi/kg	pCi/day	pCi/kg	pCi/day
Alaska:	Juneau	July	2.32	0.3	0.6	1.0	2.3	3	7	0	0	0.4	0.9
		Aug	3.10	.3	.8	0.9	2.7	2	6	0	0	.2	.8
		Sept	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Calif:	San Francisco	July	2.84	.9	2.7	1.5	4.2	6	17	19	54	2.1	6.0
		Aug	2.07	.5	1.1	1.8	2.7	3	6	11	22	.8	1.7
		Sept	1.83	.8	1.5	1.5	2.8	6	11	15	37	.9	1.6
Miss:	Columbia	July	2.39	.9	2.2	1.5	3.6	6	15	18	42	.7	1.4
		Aug	2.22	.9	2.0	1.7	3.8	10	22	20	44	.9	2.0
		Sept	1.79	.8	1.5	1.4	3.6	9	16	20	36	.8	1.4
Nebr:	Omaha	July	2.18	1.2	2.7	1.8	4.0	6	13	11	24	1.2	2.6
		Aug	2.29	.8	1.9	1.8	4.3	8	15	0	0	.6	1.4
		Sept	2.25	.8	1.7	1.8	4.1	6	14	15	32	.9	2.0
Nev:	Carson City	July	1.36	.7	.9	1.7	2.3	5	7	20	37	1.0	1.4
		Aug	1.77	.9	1.7	1.8	2.9	4	8	0	0	1.4	2.5
		Sept	1.85	.6	1.2	1.7	3.2	0	11	17	32	.8	1.5
N. Mex:	Albuquerque	July	2.45	.8	2.1	1.9	4.6	0	0	0	0	.5	1.2
		Aug	2.30	.8	2.0	1.7	4.0	5	11	0	0	.5	1.2
		Sept	2.49	.8	1.9	1.6	4.0	6	16	0	0	.5	1.3
Ore:	Woodburn	July	2.38	.6	1.4	1.9	4.5	5	12	17	40	.7	1.6
		Aug	2.41	.6	1.5	1.8	4.4	5	13	21	51	.7	1.7
		Sept	2.32	.6	1.4	1.7	4.0	4	10	20	47	.6	1.4
Utah:	American Fork	July	1.97	.6	1.2	1.3	2.5	4	7	11	22	.5	1.0
		Aug	1.89	.6	1.1	1.1	2.1	4	8	0	0	.5	.9
		Sept	1.92	.6	1.1	1.2	2.2	4	7	11	21	.1	.2
Institutional average		July	2.26	0.7	1.7	1.6	3.5	4	10	12	26	0.9	2.0
		Aug	2.27	0.7	1.5	1.6	3.5	5	12	6	15	0.7	1.5
		Sept	2.07	0.7	1.5	1.6	3.3	6	12	14	28	0.7	1.3

NA, no analysis.
NS, no sample.

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SECTION II. WATER

The Public Health Service, the Federal Water Pollution Control Administration and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*), set the limits for approval of a drinking water supply containing radium-226 and strontium-90 as 3 pCi/liter and 10 pCi/liter, respectively. Limits may be set higher if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities recently reported in *Radiological Health Data and Reports* are listed below.

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[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Last presented
California	July–December 1966	February 1968
Coast Guard	January–December 1966	November 1967
Minnesota Municipal	January–June 1967	January 1968
New York Surface	January–May 1967	January 1968
Washington Surface	July 1965–June 1966	August 1967

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(*2*) FEDERAL RADIATION COUNCIL. Radiation Protection Guidance for Federal Agencies. Memorandum for the President, September 1961. Reprint from the Federal Register of September 26, 1961.

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

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Gross Radioactivity in Surface Waters of the United States, October 1967

Division of Pollution Surveillance, Federal Water Pollution Control Administration Department of Interior

The monitoring of levels of radioactivity in surfaces waters of the United States was begun in 1957 as part of the Federal Water Pollution Control Administration's Water Pollution Surveillance System. Table 1 presents the current preliminary results of the alpha and beta radioanalyses. The radioactivity associated with dissolved solids provides a rough indication of the levels which would occur in treated water, since nearly all suspended matter is removed by treatment processes. Strontium-90 results are reported semiannually. The stations on each river are arranged in the table according to their distance from the headwaters. Figure 1 indicates the average total beta radioactivity in suspended-plus-dissolved solids in raw water collected at each station. A description of the sampling and analytical procedures was published in the August 1967 issue of *Radiological Health Data and Reports*.

During October, the following stations decreased to less than 15 pCi/liter for suspended solids;

Arkansas River; Ponca City, Okla.
Kansas River; DeSoto, Kans.
Rio Grande; Laredo, Tex.
San Juan River; Shiprock, N. Mex.
Yellowstone River; Sidney, Mont.

No station in October showed a beta radioactivity of more than 150 pCi/liter.

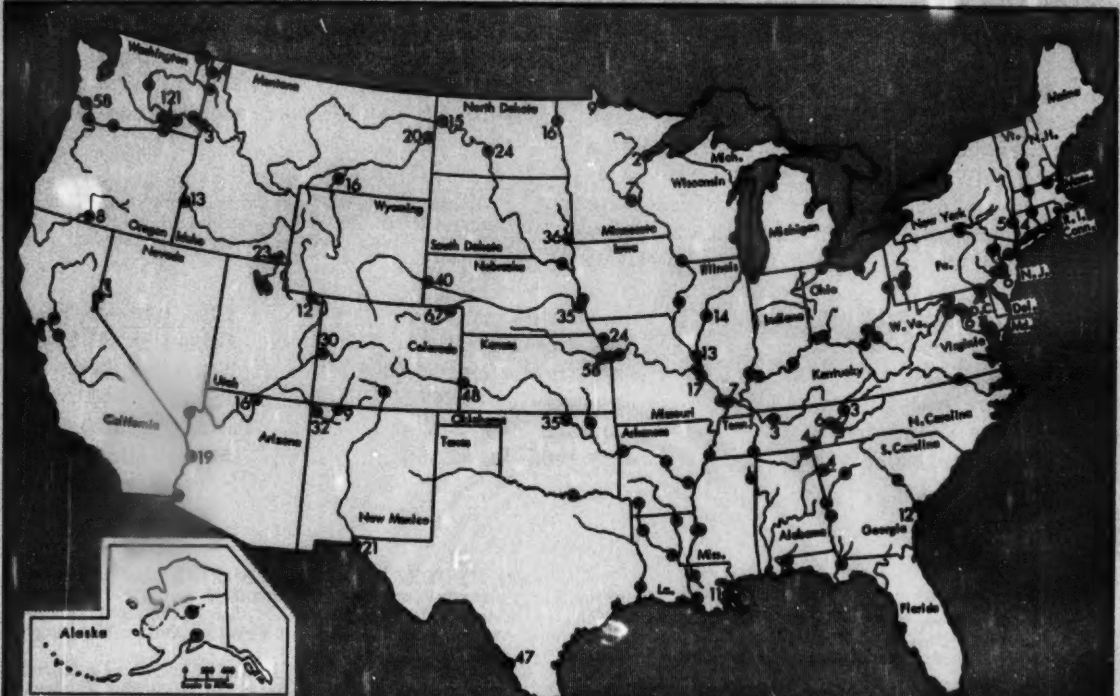
Washington
Montana
North Dakota
Wyoming
South Dakota
Nebraska
Oregon
Idaho
Nevada
Utah
Colorado
Kansas
California
Arizona
New Mexico
Oklahoma
Texas
Alaska
Minnesota
Iowa
Wisconsin
Mich.
Michigan
Illinois
Indiana
Ohio
Missouri
Kentucky
Tenn.
Arkansas
Miss.
Alabama
Georgia
La.
Florida
N. Carolina
S. Carolina
Virginia
W. Va.
Pa.
New York
N.J.
Del.
Md.
D.C.
Vt.
N.H.
Maine
R.I.
Conn.
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Figure 1. Sampling locations and associated total beta radioactivity (pCi/liter) in surface waters, October 1967

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Complete data and exact sampling locations for 1958 through 1963 are published in annual compilations (*1–6*). Data for subsequent years are available on request.

Special note is taken when the alpha radioactivity is 15 pCi/liter or greater or when the beta radioactivity is 150 pCi/liter or greater. These arbitrary levels provide a basis for the selection of certain data for comment. They reflect no public health significance as the Public Health Service drinking water standards have already provided the basis for this assessment. Changes from or toward these arbitrary levels are also noted in terms of changes in radioactivity per unit weight of solids. A discussion of gross radioactivity per gram of solids for all stations of the Water Pollution Surveillance System for 1961 through 1965 has been presented (*7*). Comments are made only on monthly average values. Occasional high values from single weekly samples may be absorbed into a relatively low average. When these values are significantly high, comment will be made.

During September and October, the following stations showed values in excess of 15 pCi/liter on alpha radioactivity for either suspended or dissolved solids:

Arkansas River; Coolidge, Kans.
North Platte River; Henry, Nebr.
South Platte River; Julesburg, Colo.

During October, Loma, Colo., on the Colorado River showed a value in excess of 15 pCi/liter on alpha radioactivity for suspended solids.

Table 1. Radioactivity in raw surface waters, October 1967

Station	Average alpha radioactivity (pCi/liter)			Average beta radioactivity (pCi/liter)		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River:						
Cedar Hill, N. Mex.	0	2	2	1	8	9
Arkansas River:						
Coolidge, Kans.	2	20	22	7	41	48
Ponca City, Okla.	8	2	10	23	12	35
Bear River:						
Preston, Idaho	1	1	2	6	17	23
Big Horn River:						
Hardin, Mont.	0	5	5	1	15	16
Big Sioux River:						
Sioux Falls, S. Dak.	<1	4	4	4	32	36
Clearwater River:						
Lewiston, Idaho	0	0	0	1	2	3
Clinch River:						
Clinton, Tenn.	0	0	0	0	3	3
Kingston, Tenn a	0	0	0	0	6	6
Colorado River:						
Loma, Colo.	2	16	18	5	25	30
Page, Ariz.	0	4	4	1	15	16
Parker Dam, Calif-Ariz.	0	7	7	1	18	19
Columbia River:						
Pasco, Wash a	0	1	1	8	113	121
Clatskanie, Ore.	0	<1	<1	8	50	58
Connecticut River:						
Enfield Dam, Conn.	0	0	0	1	3	4
Coosa River:						
Rome, Ga.	1	<1	1	1	3	4
Cumberland River:						
Cheatham Lock, Tenn.	0	0	0	1	2	3
Delaware River:						
Philadelphia, Pa.	0	0	0	1	5	6
Great Lakes:						
Duluth, Minn.	0	0	0	0	2	2
Green River:						
Dutch John, Utah	0	3	3	0	12	12
Hudson River:						
Poughkeepsie, N. Y.	0	0	0	1	4	5
Illinois River:						
Peoria, Ill.	1	1	2	5	9	14
Grafton, Ill.	1	2	3	4	9	13
Kansas River:						
DeSoto, Kans.	11	1	12	45	13	58
Klamath River:						
Keno, Ore.	0	0	0	<1	8	8
Mississippi River:						
St. Paul, Minn.	0	0	0	1	6	7
E. St. Louis, Ill.	2	1	3	7	10	17
New Orleans, La.	0	1	1	2	9	11
Missouri River:						
Williston, N. Dak.	0	4	4	2	13	15
Bismarck, N. Dak.	3	3	6	10	14	24
St. Joseph, Mo.	1	4	5	8	16	24
North Platte River:						
Henry, Nebr.	<1	26	26	3	37	40
Ohio River:						
Cairo, Ill.	0	0	0	1	6	7
Pend Oreille River:						
Albeni Falls Dam, Idaho	0	1	1	<1	4	4
Platte River:						
Plattsmouth, Nebr.	6	6	12	14	21	35
Potomac River:						
Washington, D. C.	0	0	0	1	5	6
Rainy River:						
Baudette, Minn.	0	1	1	2	7	9
Red River, North:						
Grand Forks, N. Dak.	0	1	1	1	15	16
Rio Grande:						
El Paso, Tex.	0	5	5	2	19	21
Laredo, Tex.	10	3	13	36	11	47
San Juan River:						
Shiprock, N. Mex.	7	4	11	24	8	32
Snake River:						
Payette, Idaho	0	6	6	<1	13	13
South Platte River:						
Julesburg, Colo.	3	37	40	10	57	67
Tennessee River:						
Chattanooga, Tenn.	0	0	0	<1	4	4
Yellowstone River:						
Sidney, Mont.	3	4	7	9	11	20
Maximum	11	37	40	45	113	121
Minimum	0	0	0	0	2	2

a Gross beta radioactivity at this station may not be directly comparable to gross beta radioactivity at other stations because of the possible contribution of radionuclides from an upstream nuclear facility in addition to the contribution from fallout and naturally occurring radionuclides.

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(*2*) *Ibid.*, 1959 Edition.
(*3*) *Ibid.*, 1960 Edition.
(*4*) *Ibid.*, 1961 Edition.
(*5*) *Ibid.*, 1962 Edition.
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Radiostrontium in Tap Water, January-June 1967[1]

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory has performed analyses for strontium–90 in tap water at New York City since August 1954. Samples of tap water are collected daily so that by the end of the month a composite of at least 100 liters is available for analysis. Cesium–137 determinations were begun in January 1964. The analytical methods used at the laboratory are given in the Health and Safety Laboratory Manual of Standard Procedures (*1*).

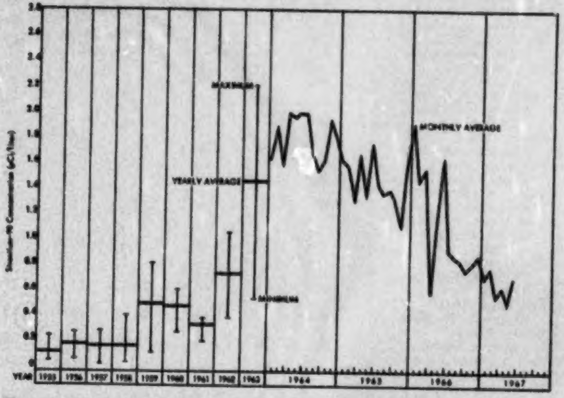

Figure 1. Strontium–90 concentrations in New York City tap water, 1955–June 1967

Table 1. Radiostrontium in New York City tap water January–June 1967

Date 1967	Strontium-90 * (pCi/liter)	Cesium-137/ strontium-90 ratios
January	0.71	0.06
February	.76	.05
March	.56	.07
April	.61	.10
May	.50	.12
June	.70	.08

* Approximately 100 liters per sample.

Strontium–90 concentration and cesium–137/strontium–90 ratios in New York City tap water for January through June 1967 are presented in table 1. These results appear graphically in figure 1.

A decreasing trend has been observed in the strontium–90 concentrations since the July 1963 peak. The maximum strontium–90 concentrations observed are below the acceptable limit as set forth in the interstate carrier drinking water standards (*2*).

REFERENCES

(*1*) U.S. ATOMIC ENERGY COMMISSION. Manual of standard procedures 40:E–38–01–16. Health and Safety Laboratory, U.S. Atomic Energy Commission, 376 Hudson Street, New York 14, N.Y.
(*2*) FEDERAL REGISTER RULES AND REGULATIONS. Title 42–Public Health, Chapter 1, Public Health Service, Department of Health, Education and Welfare; Part 72, Interstate Quarantine, Subpart J, Drinking Water Standards 27:2154–2155. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 6, 1962).

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1966	November 1967

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[1] Prepared from information appearing in Fallout Program Quarterly Summary Report, HASL–184. This report is available from the Clearinghouse for Federal Scientific and Technical Information, CFSTI, 5285 Port Royal Road, Springfield, Va. 22151.

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta-particle analysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the U.S. Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

An intercomparison of the above networks was performed by Lockhart and Patterson in 1962 and is summarized in the January 1964 issue of *Radiological Health Data*. In addition to those programs presented in this issue, the following programs were previously covered in *Radiological Health Data and Reports*.

Network	Period	Issue
HASL 80th Meridian Network	January–June 1967	March 1968
Plutonium in Airborne Particulates	April–June 1967	November 1967

1. Radiation Alert Network
December 1967

National Center for Radiological Health
U.S. Public Health Service

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 78 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate and dried precipitation samples and report the results to appropriate NCRH officials by mail or telephone, depending on levels found. Compilation of the daily field estimates is reported elsewhere on a monthly basis (*1*). A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique, during December 1967. Time profiles of gross beta radioactivity in air for eight Radiation Alert Network stations are shown in figure 2.

Concentrations of radioactive particulates in surface air were at normal levels until the last week of the month when a brief rise occurred at most stations. Table 2 lists 5-hour field estimates on air samples reported that were in excess of 15 pCi/m³. Table 3 lists air samples that were identified as containing fresh fission product radioactivity.

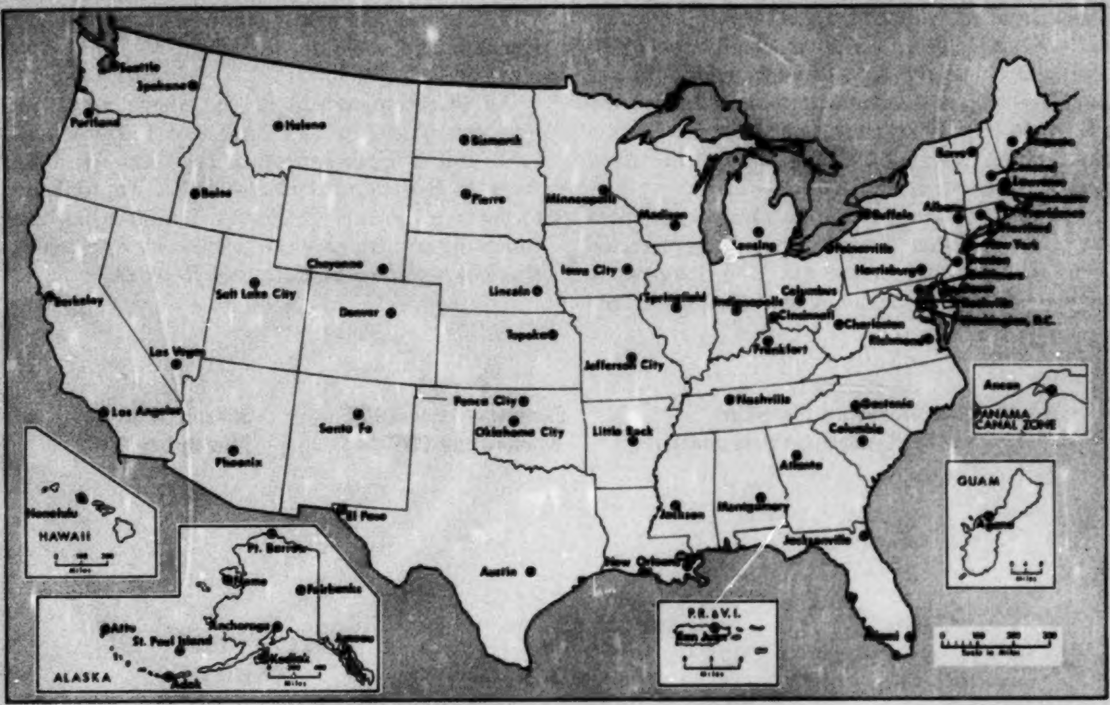
Seattle
Spokane
Portland
Helena
Bismarck
Boise
Pierre
Minneapolis
Madison
Lansing
Buffalo
Albany
Barre
Painesville
New York
Harrisburg
Cheyenne
Iowa City
Lincoln
Salt Lake City
Denver
Berkeley
Springfield
Indianapolis
Columbus
Cincinnati
Charleston
Washington, D.C.
Richmond
Frankfort
Topeka
Jefferson City
Las Vegas
Los Angeles
Ponca City
Oklahoma City
Santa Fe
Nashville
Gastonia
Little Rock
Columbia
Phoenix
Atlanta
Jackson
Montgomery
Jacksonville
El Paso
New Orleans
Austin
Miami
Honolulu
HAWAII
Pt. Barrow
Nome
Fairbanks
Anchorage
Attu
St. Paul Island
Kodiak
Juneau
Adak
ALASKA
Ancon
PANAMA CANAL ZONE
GUAM
Agana
P.R. & V.I.
San Juan
Miles
Scale in Miles

Figure 1. Radiation Alert Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, December 1967

Station location	Number of samples		Air surveillance: Gross beta radioactivity (pCi/m³)			Last profile in RHD & R	Precipitation	Field estimation of deposition [b]		
	Air	Pyro	Maximum	Minimum	Average [a]		Total depth (mm)	Number samples	Depth (mm)	Total deposition (nCi/m²)
Ala: Montgomery	21	12	9.36	0.15	1.81	Nov 67	169	3	53	1
Alaska: Adak	7	------	.38	.25	.38	Apr 68	(c)			
Anchorage	16	7	.46	.00	.06	Dec 67	36	7	36	6
Attu Island	8	------	.61	.00	.05	July 67	(c)			
Fairbanks	(c)	------	------	------	------	Jan 68	(c)			
Juneau	21	15	.35	.03	.03	Feb 68	169	13	169	23
Kodiak	21	------	6.11	.03	.41	Mar 68	(c)			
Nome	20	------	.77	.00	.36	Sept 67	(c)			
Pt. Barrow	21	------	.64	.01	.31	Aug 67	(c)			
St. Paul Island	20	------	1.31	.44	.86	Oct 67	(c)			
Ariz: Phoenix	22	------	22.43	.19	6.96	Feb 68	(c)			
Ark: Little Rock	18	9	1.11	.11	.46	Dec 67	157	2	81	0
Calif: Berkeley	24	8	5.60	.00	.75	Mar 68	57	5	57	0
Los Angeles	24	5	7.30	.35	.86	Mar 68	56	5	56	0
C. Z.: Ancon	[e]	------	------	------	------	Mar 68	(c)			
Colo: Denver	22	2	10.13	.30	3.15	Mar 68	0	0	0	(d)
Conn: Hartford	22	8	1.08	.00	.27	Jan 68	126	8	126	155
Del: Dover	11	------	9.86	.00	.30	Nov 67	(c)			
D. C: Washington	20	10	9.82	.25	1.83	Aug 67	148	10	148	38
Fla: Jacksonville	21	6	9.75	.00	1.01	Dec 67	112	2	47	0
Miami	21	4	.30	.08	.17	Jan 68	25	4	25	0
Ga: Atlanta	16	9	9.95	.83	1.98	Oct 67	165	9	165	96
Guam: Agana	[e]	------	------	------	------	May 67	(c)			
Hawaii: Honolulu	21	5	1.19	.20	.45	July 67	164	0	0	(d)
Idaho: Boise	24	0	11.00	.34	1.65	July 67	5	5	5	0
Ill: Springfield	20	9	1.80	.00	.80	Aug 67	168	0	0	
Ind: Indianapolis	21	11	6.89	.25	.91	Oct 67	126	11	126	116
Iowa: Iowa City	22	1	4.33	.91	1.72	Mar 68	7	1	7	0
Kans: Topeka	22	5	6.96	.25	.85	Dec 67	47	5	47	31
Ky: Frankfort	11	5	1.36	.58	.86	Aug 67	24	5	24	163
La: New Orleans	21	7	2.66	.00	.35	Aug 67	269	0	0	(d)
Maine: Augusta	22	10	1.10	.00	.35	Feb 68	168	10	168	13
Md: Baltimore	22	5	.75	.00	.38	Jan 68	99	5	99	18
Rockville	9	1	.48	.01	.08	July 67	89	0	0	(d)
Mass: Lawrence	22	6	.65	.00	.30	Nov 67	142	2	65	35
Winchester	20	7	4.41	.00	.32	Apr 68	121	7	121	0
Mich: Lansing	21	------	1.98	.22	.71	July 67	(c)			
Minn: Minneapolis	21	4	.73	.19	.30	Nov 67	9	4	9	0
Miss: Jackson	17	6	1.18	.00	.37	Feb 68	194	6	194	165
Mo: Jefferson City	22	10	1.62	.14	.35	Oct 67	74	10	74	1
Mont: Helena	22	8	1.88	.22	.56	Apr 68	25	8	25	31
Nebr: Lincoln	20	3	6.06	.08	2.35	Oct 67	16	3	16	0
Nev: Las Vegas	22	------	4.70	.15	1.30	Jan 68	(c)			
N. H: Concord	21	------	2.23	.00	.48	Aug 67	(c)			
N. J: Trenton	20	4	4.93	.00	.55	Feb 68	66	4	66	22
N. Mex: Santa Fe	21	5	9.86	.18	1.07	Apr 68	53	5	53	4
N. Y: Albany	22	11	2.11	.20	.57	Oct 67	75	10	75	124
Buffalo	(c)	------	------	------	------	Mar 68	(c)			
New York	22	------	4.98	.13	.40	Apr 68	(c)			
N. C: Gastonia	17	5	10.46	.55	3.49	Mar 68	56	0	0	(d)
N. Dak: Bismarck	22	3	4.25	.20	1.46	Aug 67	10	3	0	0
Ohio: Cincinnati	18	------	6.85	.40	1.18	Nov 67	(c)			
Columbus	20	7	1.17	.12	.42	Feb 68	50	5	44	0
Painesville	22	9	6.29	.13	.39	Jan 68	46	9	46	51
Okla: Oklahoma City	19	1	5.64	.27	1.06	July 67	12	1	12	12
Ponca City	22	4	4.63	.23	.83	Jan 68	29	4	29	18
Oreg: Portland	23	15	2.98	.00	.35	Oct 67	89	15	89	0
Pa: Harrisburg	16	1	6.92	.41	1.23	Oct 67	45	0	0	
P. R: San Juan	10	1	.00	.00	.00	Feb 68	25	1	25	0
R. I: Providence	21	4	3.11	.00	.36	July 67	124	2	22	19
S. C: Columbia	6	2	2.95	.00	.41	Apr 68	22	0	0	
S. Dak: Pierre	14	------	5.10	1.14	3.25	Feb 68	(c)			
Tenn: Nashville	17	9	.98	.28	.56	July 67	122	9	122	0
Tex: Austin	16	3	6.03	.37	1.77	Nov 67	66	0	0	(d)
El Paso	20	3	7.09	.04	3.04	Aug 67	20	3	20	0
Utah: Salt Lake City	21	12	5.17	.24	.80	Sept 67	47	7	20	10
Vt: Barre	21	7	1.93	.00	.37	Dec 67	73	7	73	27
Va: Richmond	18	7	2.10	.21	.72	Dec 67	120	3	64	10
Wash: Seattle	6	14	27.95	.00	8.20	Dec 67	105	0	0	(d)
Spokane	22	1	2.73	.24	.75	Nov 67	1	1	1	0
W. Va: Charleston	22	12	1.51	.24	.66	Apr 68	113	12	113	150
Wis: Madison	22	9	1.25	.09	.50	Dec 67	48	9	48	42
Wyo: Cheyenne	22	6	9.68	.09	1.28	Jan 68	11	6	11	11
Network summary	1,388	382	27.95	0.00	1.02		78	6	63	30

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] The data in these columns apply only to samples for which field estimates were made.
[c] Indicates no report received. (Air samples received without field estimate data are not considered by the data program.)
[d] Indicates no precipitation sample collected.
[e] Indicates the station is part of the plutonium in precipitation network. No gross beta measurements are done.

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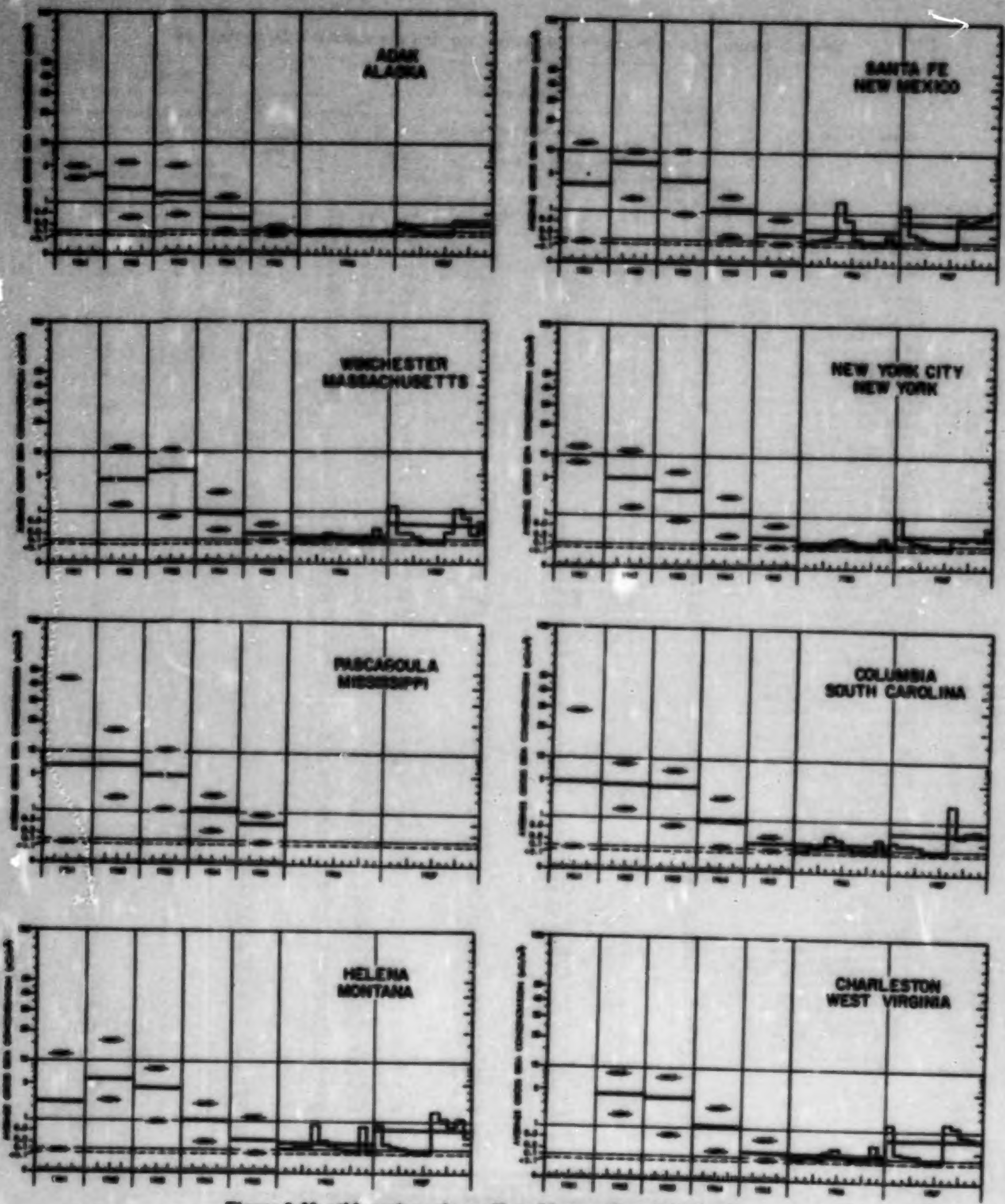

Figure 2. Monthly and yearly profiles of beta radioactivity in air—
Radiation Alert Network, 1961–December 1967

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Table 2. RAN air samples with gross beta radioactivity concentration greater than 15 pCi/m³ at 5 hours after collection

Location	Collection date	5-hour field estimate (pCi/m³)
Denver, Colo.	12/26/67	[illegible]
Phoenix, Ariz.	[illegible]	[a] [illegible]
Seattle, Wash.	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]

[a] Believed to be due to natural radioactivity. Decayed to 0.41 pCi/m³ in 24 hours. No evidence of fresh fission products.

Table 3. RAN air samples in which fresh fission products were identified by gamma-ray spectroscopy[a]

Date (1967)	Location	
12/28	Utah:	Salt Lake
	Wyo:	Cheyenne
	Alaska:	Kodiak
12/29	N. Mex:	Santa Fe
	Colo:	Denver
12/30	Ala:	Montgomery
	Kans:	Topeka
	Okla:	Oklahoma City
	Colo:	Denver
	Idaho:	Boise
	Calif:	Berkeley
	Wash:	Seattle
12/31	D.C.	Washington
	Fla:	Jacksonville
	Ga:	Atlanta
	Ala:	Montgomery
	Ind:	Indianapolis
	Ohio:	Cincinnati
		Painesville
	Nebr:	Lincoln
	Calif:	Berkeley
	Wash:	Seattle

[a] These samples, when scanned, showed the presence of short-lived iodines and barium-lanthanum-140.

2. Canadian Air and Precipitation Monitoring Program[1]
December 1967

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations (figure 3) are located at airports, where the sampling equipment is operated by personnel from the Meteorologic Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*2–6*).

Air sampling procedure and results

Each air sample involves the collection of particulates from about 650-cubic meters of air drawn through a high efficiency 4-inch diameter glass-fiber filter during a 24-hour period. These filters are sent daily to the Radiation Protection Division Laboratory in Ottawa for analysis.

To determine the beta radioactivity, a 2-inch diameter disk is cut from each filter and counted with a thin-end window, gas flow,

Table 4. Canadian gross beta radioactivity in surface air and precipitation, December 1967

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	31	1.2	0.0	0.1	NS	NS
Coral Harbour	31	0.1	.0	.0	9	0.2
Edmonton	31	3.3	.0	.2	696	27.7
Ft. Churchill	31	.1	.0	.0	7	.1
Ft. William	31	.2	.0	.0	370	10.4
Fredericton	17	.2	.0	.0	42	8.5
Goose Bay	31	3.5	.0	.1	16	1.4
Halifax	31	.6	.0	.0	16	3.9
Inuvik	31	.1	.0	.0	13	.2
Montreal	31	1.4	.0	.1	177	10.6
Moosonee	31	.5	.0	.1	10	.4
Ottawa	31	.3	.0	.0	25	1.4
Quebec	31	2.7	.0	.2	94	9.1
Regina	31	1.6	.0	.1	30	.9
Resolute	31	.1	.0	.0	3	.2
St. John's, Nfld.	31	.2	.0	.0	56	4.3
Saskatoon	31	3.4	.0	.1	117	2.7
Sault Ste Marie	31	0.2	.0	.0	23	2.2
Toronto	30	.5	.0	.1	12	.9
Vancouver	31	17.9	.0	.7	39	5.1
Whitehorse	31	.3	.0	.0	18	.3
Windsor	31	.2	.0	.0	13	2.0
Winnipeg	31	5.3	.0	.2	88	1.9
Yellowknife	31	.1	.0	.0	17	.2
Network summary	729	17.9	0.0	0.1	80	4.4

NS, no sample.

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[1] Prepared from January 1968 monthly report "Data from Radiation Protection Programs," Canadian Department of National Health and Welfare, Ottawa, Canada.

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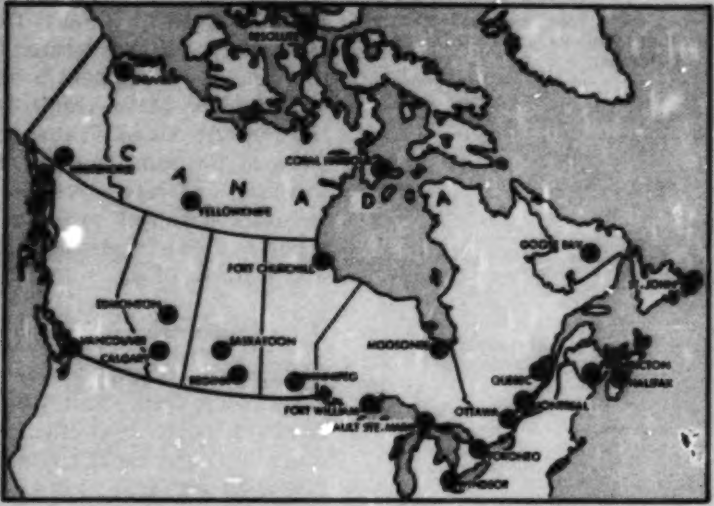

Figure 3. Canadian air and precipitation sampling stations

Geiger-Mueller counter system calibrated with a strontium-yttrium–90 standard. Four successive measurements are made on each filter to permit correction for natural activities and for the decay of short-lived fission products. The results are extrapolated to the end of the sampling period. Canadian air data for December 1967, are presented in table 2.

Precipitation collection and analysis

The amount of radioactive fallout deposited on the ground is determined from measurements on material collected in special polyethylene-lined rainfall pots. The collection period for each sample is 1 month. After transfer of the water to the sample container, the polyethylene liner is removed, packed with the sample, and sent to the laboratory.

Strontium and cesium carriers are added to all samples on arrival at the laboratory. Other carriers are added to selected samples depending upon the specific radionuclides to be determined. The samples are then filtered and the filtrate evaporated to near dryness. The filter paper containing insoluble matter together with the polyethylene liner is then ignited and ashed at 450°C. The ash is combined with the soluble fraction, transferred to a glass planchet, evaporated under an infrared lamp and then counted with a thin-end window Geiger-Mueller counter calibrated with a strontium-yttrium–90 source.

The monthly precipitation samples represent the total deposition of radioactive materials on the earth's surface. The December 1967 gross beta deposition values are given in table 4.

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3. Mexican Air Monitoring Program
December 1967

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico was established by the Comisión Nacional de Energía Nuclear (CNEN), México, D.F. From 1952 to 1961, the network was directed by the Institute of Physics of the University of Mexico, under contract to the CNEN.

In 1961, the CNEN appointed its Division of Radiological Protection to establish a new Radiation Surveillance Network. In 1966, the Division of Radiological Protection was restructured and its name changed to Dirección General de Seguridad Radiológica (DRS). The network consists of 16 stations (figure 4), 11 of which are located at airports and operated by airline personnel. The remaining five stations are located at México, D.F.; Mérida; Veracruz; San Luis Potosí; and Ensenada.

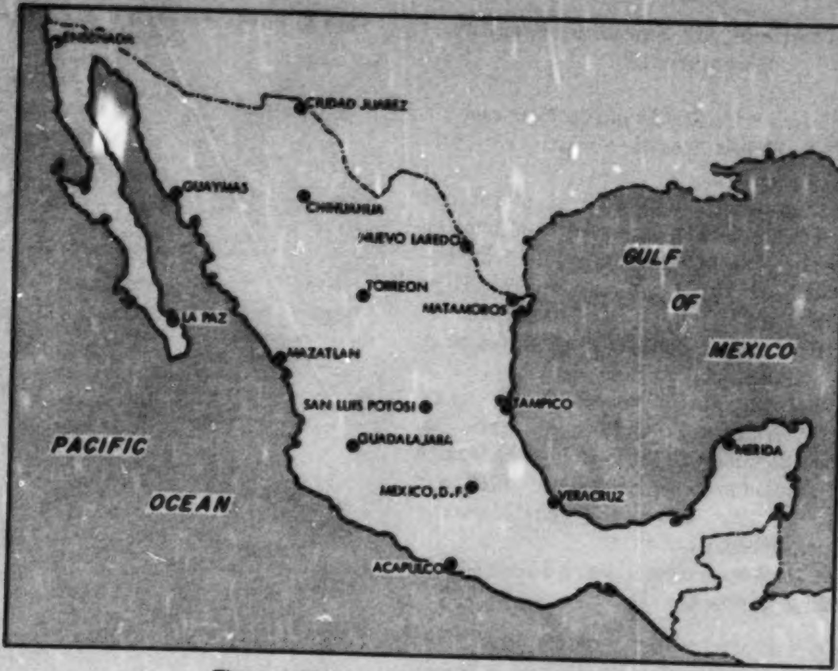
ENSENADA
CIUDAD JUAREZ
GUAYMAS
CHIHUAHUA
NUEVO LAREDO
TORREON
MATAMOROS
LA PAZ
MAZATLAN
GULF
OF
MEXICO
SAN LUIS POTOSI
TAMPICO
GUADALAJARA
MERIDA
PACIFIC
OCEAN
MEXICO, D.F.
VERACRUZ
ACAPULCO

Figure 4. Mexican air sampling locations

Staff members of the DRS operate the station at México, D.F., while the other four stations are manned by members of the Centro de Prevision del Golfo de Mexico, the Chemistry Department of the University of Merida, the Institute de Zonas Desérticas of the University of San Luis Potosí, and the Escuela Superior de Ciencias Marinas of the University of Baja California, respectively.

Sampling

The sampling procedure involves drawing air through a high-efficiency 6- by 9-inch glass-fiber filter for 20 hours a day, 3 or 4 days a week at the rate of 1,000 cubic meters per day using high volume samplers.

After each 20 hour sampling period, the filter is removed and shipped via airmail to the Sección de Radioactividad Ambiental, CNEN, in México, D.F., for assay of gross beta radioactivity, allowing a minimum of 3 or 4 days after collection for the decay of radon and thoron. The data are not extrapolated to the time of collection. Statistically, it has been found that a minimum of five samples per month were needed to get a reliable average radioactivity at each station (*7*).

The maximum, minimum, and average beta radioactivity in surface air during December 1967 are presented in table 5.

Table 5. Mexican gross beta radioactivity of airborne particulates, December 1967

Station	Number of samples	Gross beta radioactivity (pCi/m^3)		
		Maximum	Minimum	Average
Acapulco	13	0.5	0.1	0.1
Chihuahua	4	.3	.1	.2
Ciudad Juarez	15	.2	.1	.1
Ensenada	3	.1	.1	NS
Guadalajara	11	.1	.1	.1
Guaymas	NS	NS	.1	NS
La Paz	NS	NS	.1	NS
Matamoros	NS	NS	.1	NS
Mazatlán	5	.1	.1	[illegible]
Mérida	6	.3	.1	.1
México, D. F.	7	1.7	.1	.3
Nuevo Laredo	NS	NS	.1	NS
San Luis Potosí	NS	NS	.1	NS
Tampico	6	.1	.1	.1
Torreon	13	.2	.1	.1
Veracruz	9	.1	.1	.1

NS, no sample collected, station temporarily shutdown.

4. Pan American Air Sampling Program December 1967

Pan American Health Organization and U.S. Public Health Service

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the U.S. Public Health Service (PHS) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 5. Analytical techniques were described in the January 1968 *Radiological Health Data and Reports*. The December 1967 air monitoring results from the participating countries are given in table 6.

No fresh fission products were identified in the December samples.

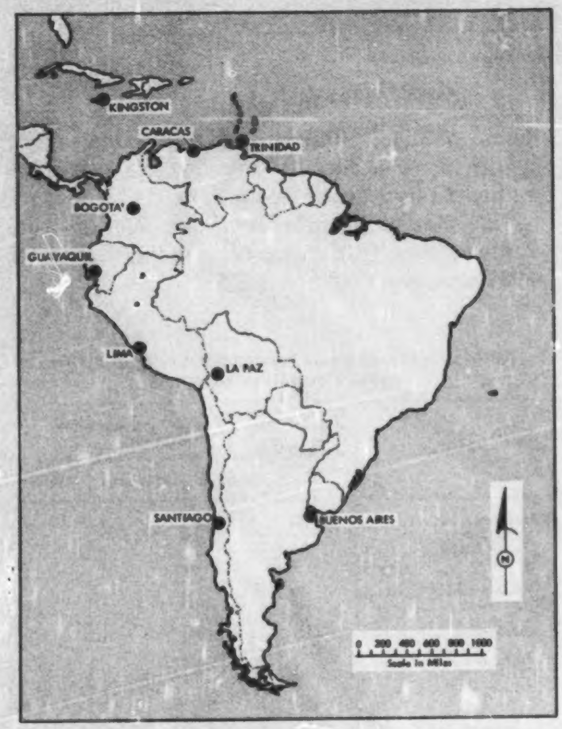

Figure 5. Pan American Air Sampling Program stations

Table 6. PAHO gross beta radioactivity in surface air December 1967

Station location		Number of samples	Gross beta radioactivity (pCi/m³ [a])		
			Maximum	Minimum	Average
Argentina:	Buenos Aires	[b]			
Bolivia:	La Paz	20	0.03	0.01	0.01
Chile:	Santiago	30	.06	.00	.02
Colombia:	Bogota	19	.03	.00	.01
Ecuador:	Guayaquil	30	.06	.02	.03
Jamaica:	Kingston	19	.05	.00	.02
Peru:	Lima	3	.05	.03	.03
Venezuela:	Caracas	11	.01	.00	.01
West Indies:	Trinidad	11	.02	.00	.01
Pan American summary		143	0.06	0.00	0.02

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

[b] No December samples received.

REFERENCES

(*1*) PUBLIC HEALTH SERVICE, NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Environmental radiation surveillance report. National Center for Radiological Health, Standards and Intelligence Branch, Rockville, Md. 20852 (Distribution by official request).

(*2*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW-RP-3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*3*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW-RP-4, Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*4*) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW-RP-5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*5*) BEALE, J., and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD-11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*6*) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD-21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

(*7*) VASQUEZ, M., and R. M. DE NULMAN. Estudios sobre la radioactividad ambiental en la Republica Mexicana, 1963–1965. Comisión Nacional de Energía Nuclear, Dirección General de Seguridad Radiológica (in press 1966).

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SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, bovine thyroid sampling, Alaskan surveillance and environmental monitoring around nuclear facilities.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major AEC installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the AEC Manual.[1]

Summaries of data from the environmental radioactivity monitoring reports follow for the Lawrence Radiation Laboratory and the Mound Laboratory.

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[1] Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation," contains essentially the standards published in Chapter 0524 of the AEC Manual.

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1. Lawrence Radiation Laboratory
January–June 1967[2]

University of California
Berkeley, California

Berkeley site

The Berkeley site of the Lawrence Radiation Laboratory (LRL) is situated on the western slope of the range of hills running along the eastern side of San Francisco Bay. The laboratory area is largely separated from the main campus of the University, although there is some overlap.

To the north and south of the laboratory area are residential areas of the cities of Berkeley and Oakland. The Berkeley campus of the university of California is on the west; to the east is uninhabited watershed land and the Tilden Regional Park.

The most prevalent wind direction is westerly. During the summer months the afternoon sea breeze establishes a very pronounced prevailing westerly wind direction. At other times, the direction is less predictable. Annual rainfall is 23 inches, almost all of which falls between November 1 and May 1. The prevailing wind direction during precipitation is southerly.

The laboratory carries on a wide ranging program of general research in the fields of both physical and biological sciences. Facilities include a number of large accelerators, and vari-

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[2] Summarized from "Results of Environmental Radioactivity Sampling Program, January–June 1967," Lawrence Radiation Laboratory, Livermore and Berkeley, Calif.

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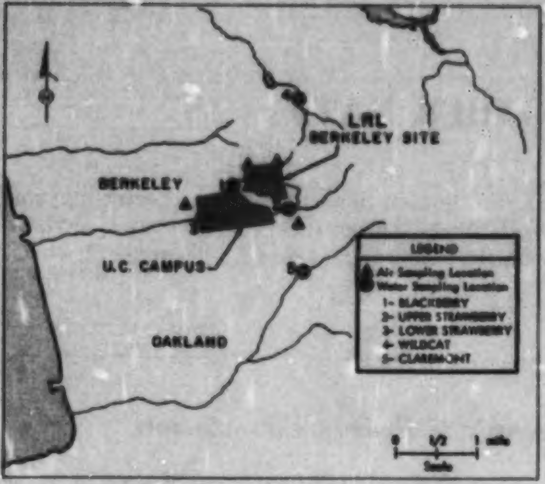

Figure 1. Environmental sampling locations at the Berkeley site

ous physics, chemistry, biology and medical research laboratories.

The basic policy at LRL has long been to prevent, as far as possible, any release of radioactive material to the environment, no matter how small. No deliberate releases are sanctioned, except where no practical method for containment has yet been developed and quantites are small compared with standards established by the ICRP and AEC.

The most sensitive measurements of releases are those taken closest to the source itself, before dilution makes detection of small quantities more difficult. The stack sampling program, therefore, provides the most useful information for controlling releases to the atmosphere. Over 100 separate exhausts from hoods and glove box manifolds are sampled. The total quantities released from these stacks during the 6 months were 0.4 microcuries alpha-particle and 600 microcuries of beta-particle emitters. The average concentrations in the total exhaust, before any dilution by the atmosphere, was 12 percent of the maximum permissible concentration for offsite breathing zone air, as given by the ICRP.

In addition to the careful sampling of stacks, an environmental air sampling program is also carried on to make sure no undetected releases occur. These samples provide a direct measurement of possible exposure to the nearby population. The sampling stations designated "local area" are scattered around the site and provide samples of the atmosphere on the site itself. The "perimeter" samples are taken at the boundary line of University property, in the direction of populated areas. From the results of these samples, it is apparent that there has been no significant exposure from radioactive materials released by LRL. The levels of radioactivity observed in each type of sample are presented in table 1.

Table 1. Atmospheric monitoring, LRL Berkeley site January–June 1967

Sampling locations (number of locations)	Number of samples	Concentration (pCi/m³)			
		Alpha radioactivity		Beta radioactivity	
		Average	Maximum	Average	Maximum
Local area (9)	215	0.000	0.004	0.15	2.67
Perimeter (4)	102	.000	.004	.33	5.25

Table 2. Total deposition, LRL Berkeley site January–June 1967

Sampling locations (number of locations)	Number of samples	Deposition (nCi/m²)			
		Alpha radioactivity		Beta radioactivity	
		Average	Maximum[a]	Average	Maximum
Local area (9)	51	0.05	0.13	19.96	72.38
Perimeter (4)	24	.12	.22	31.96	57.94

[a] Maximum deposition at a single location for the 6-month period.

At each of these environmental stations rain or dry "fallout" is also collected. Open 15-inch diameter polyethylene bags form the collecting vessel. If no rain has fallen, the bags are rinsed out with dilute nitric acid. Results from these collections show a lot of variation, without any consistent pattern. Since on the average, the more remote perimeter stations show more radioactivity than the nearer ones, it must be assumed that the radioactivity does not result from laboratory operations.

All liquid waste known to be radioactive is collected, solidified, and shipped away. Other liquid wastes are discharged directly to the municipal sewer system. Small quantities of radioisotopes now and then are accidentally released to the sewer system. There are two outfalls, each of which is monitored by a continuous proportional sampling system to insure that no significant quantities have been discharged. The total concentration (alpha-plus-beta radioactivity) in sewage is only 21 percent of the standard for drinking water and therefore does not constitute a serious exposure threat. A sizeable fraction of the measured beta concentration is the naturally occurring isotope, potassium-40 from human wastes and chemicals.

The storm drainage from the laboratory flows into the surface stream system. These surface streams are exposed as they run through the University property and are sampled at three places. Results are listed as "onsite streams" in the table. Two nearby offsite streams are also sampled to provide a comparison. No alarming concentrations have been observed. All are safely below the standard for drinking water. The results from the water sampling program are presented in table 3.

Table 3. Water monitoring, LRL Berkeley site January–June 1967

Type and source of sample	Number of samples	Concentration (pCi/liter)			
		Alpha radioactivity		Beta radioactivity	
		Average	Maximum	Average	Maximum
Sewage:					
Hearst sewer	24	0.38	3.36	18.5	63.6
Strawberry sewer	24	.47	1.94	14.0	47.4
Tap water	26	.11		2.43	
Surface water:					
Onsite streams	77	.83	3.2	6.46	45.0
Offsite streams	52	.66	3.3	2.85	23.7

Neutron and gamma-ray fields are measured at each of the four perimeter stations as well as at several locations within the site. Background measurements are obtained from a leased building used as a low level counting room in downtown Berkeley. This building is remote from the main LRL site and measurements are not influenced by accelerator operations.

There is a notable decrease at all of the monitoring sites for the 6-month period, January–June 1967, due to the shutdown of the bevatron for repair and modification. All sites are affected more or less by all machines. However, the bevatron is the largest source of radiation seen throughout the four stations except during certain operating conditions at the 88-inch cyclotron.

Improved shielding along the bevatron external beam line should limit the stray radiation to a somewhat lower value than previously noted, assuming similar beam currents.

Agriculture is the principal activity in the Livermore Valley. Roses, grain, hay, and grapes are the major products. Several cattle and sheep ranches surround the Livermore site.

Livermore site

The Livermore site of LRL (figure 2) is located in the Livermore Valley midway between the Pacific coast and the San Joaquin Valley in northern California—approximately 50 miles southeast of San Francisco. Shielded from the ocean by the western hills, the Livermore Valley has a warm, dry climate. Annual rainfall is about 14 inches and the relative humidity is about 30 percent during the summer months and about 40-50 percent the remainder of the year. Prevailing winds are from the west, but inversions are frequent during the night. Technical facilities include a small cyclotron, a 2-megawatt swimming pool reactor, and physics and chemistry programs associated with a weapons development program.

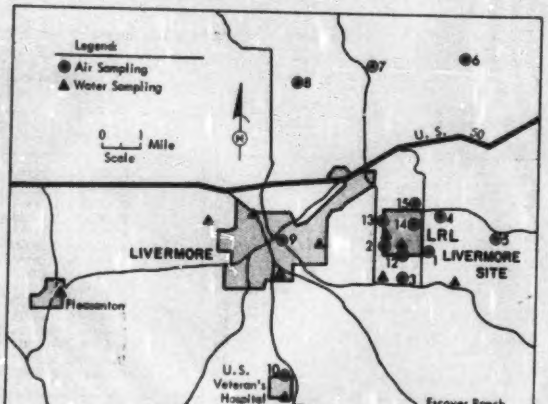

Figure 2. Environmental sampling locations at the Livermore site

The Livermore site comprises an area of 1 square mile, approximately 3 miles east of the city of Livermore. Livermore and Pleasanton, with a combined population of 45,000, are populated areas of primary interest to the Livermore site.

An environmental sampling program is maintained to provide information regarding the effectiveness of control measures and to determine whether any radiological changes in the environment are the result of laboratory operations. The sampling program includes air particulates, soil, domestic water, sewer effluent, sewage plant products, milk, and vegetation. The milk samples are obtained from two dairies in the Livermore Valley and one in another valley about 25 miles away, which is used as a check. Air and soil samples are collected to ascertain that control efforts are restricting the release of radioactivity from the laboratory to levels which do not exceed the permissible levels for the neighborhood around an atomic energy facility. The water samples are collected to monitor radioactivity in an underground water supply which provides most of the domestic water for the cities of Livermore and Pleasanton, and is the sole supply for ranches in the Livermore and Amador Valleys.

Air samples are collected continuously at 15 sites within 5 miles of the laboratory. Samples are collected at a rate of 4 cfm on 100-square centimeter HV-70 filter papers, which are changed after every 7 days of operation. A minimum decay period of 96 hours is observed before the samples are counted to eliminate the effect of natural radon and thoron daughters. All environmental air samples are counted in an automated system which utilizes gas flow proportional detectors for both alpha and beta radioactivity measurements. Alpha radioactivity in 362 air samples collected from 15 sampling locations averaged 0.0010 pCi/m³. The average beta radioactivity was higher than the average for last year—0.17 pCi/m³ (1967), versus 0.06 pCi/m³ (1966). The applicable AEC radiation protection standards are 0.040 pCi/m³ for alpha-particle emitters and 1 pCi/m³ for beta-particle emitters.

The measurement of low level "background" radiation during this period was accomplished with thermoluminescent dosimeters located at nine points on the site perimeter and at two nearby ranches. The limit of detection for these dosimeters is 20 mR. One dosimeter at a point opposite cobalt-60 irradiation facility recorded 92 mR for the 6-month period. All others were below the limit of sensitivity or less than 0.005 mR/hr.

Domestic water samples were collected monthly from nine nearby sources. The alpha radioactivity concentrations fluctuated from the limit of sensitivity (5.0 pCi/liter) to a high of

Table 4. Average radioactivity in air particulates around the Livermore site

Sampling location	Number of samples	Alpha radioactivity [a] (pCi/m³)		Beta radioactivity [a] (pCi/m³)	
		Average	High	Average	High
1	29	0.0002 ± 0.0001	0.0003 ± 0.0001	0.196 ± 0.020	3.231 ± 0.32
2	29	0.0002 ± 0.0001	0.0010 ± 0.0003	0.231 ± 0.023	4.629 ± 0.46
3	19	0.0010 ± 0.0003	0.0010 ± 0.0003	0.170 ± 0.017	2.223 ± 0.22
4	19	0.0010 ± 0.0003	0.0010 ± 0.0003	0.302 ± 0.030	2.228 ± 0.22
5	25	0.0010 ± 0.0003	0.0010 ± 0.0003	0.146 ± 0.015	2.083 ± 0.21
6	25	0.0010 ± 0.0003	0.0010 ± 0.0003	0.152 ± 0.015	3.164 ± 0.32
7	20	0.0010 ± 0.0003	0.0010 ± 0.0003	0.116 ± 0.012	1.290 ± 0.12
8	18	0.0010 ± 0.0003	0.0010 ± 0.0003	0.172 ± 0.017	1.832 ± 0.18
9 [b]	14	0.0010 ± 0.0003	0.0010 ± 0.0003	0.025 ± 0.003	0.045 ± 0.005
10	23	0.0010 ± 0.0003	0.0010 ± 0.0003	0.162 ± 0.016	2.177 ± 0.22
11	26	0.0010 ± 0.0003	0.0010 ± 0.0003	0.155 ± 0.016	2.111 ± 0.21
12	30	0.0002 ± 0.0001	0.0002 ± 0.0001	0.166 ± 0.017	2.452 ± 0.25
13	27	0.0002 ± 0.0001	0.0002 ± 0.0001	0.163 ± 0.016	2.277 ± 0.23
14	28	0.0002 ± 0.0001	0.0002 ± 0.0001	0.194 ± 0.019	3.118 ± 0.31
15	30	0.0002 ± 0.0001	0.0005 ± 0.0002	0.194 ± 0.019	3.277 ± 0.33
Overall average		0.0010 +0.0003 −0.0007		0.169 ± 0.017	

[a] Limits of sensitivity: locations 3-11 0.0010 pCi/m³ (alpha radioactivity), 0.010 pCi/m³ (beta radioactivity)
locations 1-2; 12-15 0.0002 pCi/m³ (alpha radioactivity), 0.0020 pCi/m³ (beta radioactivity)
Variations in limits of sensitivity result from differing sample flow rates.
Applicable standards of comparison stated in AEC Manual Chapter 0524 are 0.040 pCi/m³ for alpha-particle emitters, and 1 pCi/m³ for beta-particle emitters.

[b] Site was not in operation until March 21.

21 pCi/liter. A resample showed the high location to be below the limit of sensitivity. The beta radioactivity fluctuated from the limit of sensitivity (1.8 pCi/liter) to 8 pCi/liter. The average alpha radioactivity concentration was ≤6.3 pCi/liter, and the average beta radioactivity concentration was 2.6 pCi/liter. The average alpha and beta radioactivity concentrations were below the respective AEC standards of comparison of 10 and 100 pCi/liter.

The average tritium content was at or below the limit of sensitivity (5,000 pCi/liter), which is well below the standard of comparison of 5×10^{6} pCi/liter.

Samples were collected every Monday, Wednesday, and Friday at the laboratory sewer discharge. On May 25, a 3-day sample was analyzed which contained an alpha radioactivity concentration of 280 pCi/liter. At no time was the concentration guide for uncontrolled drinking water exceeded.

For the 6-month period of January to June 1967, the average alpha radioactivity concentration in laboratory sewage samples was 154 pCi/liter, mostly as a result of the May release, and the average beta radioactivity concentration was 79 pCi/liter. The average tritium concentration was 8.9×10^{4} pCi/liter. Grab samples are collected monthly at the city of Livermore sewage disposal plant to assure that the liquid effluent from the laboratory is not creating abnormal radioactivity concentrations either in the oxidation ponds (which overflow into a natural waterway) or in the dried sludge (which is used as an agricultural soil conditioner).

Samples of top-layer soil are collected quarterly at the 19 sampling stations surrounding the Livermore site. The alpha radioactivity fluctuated from the limit of sensitivity (1.5 pCi/g) to 13 pCi/g. The beta radioactivity fluctuated from the limit of sensitivity (3.5 pCi/g) to a high of 15 pCi/g. The average alpha radioactivity was 2.0 pCi/g and the average beta radioactivity was 8.2 pCi/g. The concentrations detected are within the normal range for soil in the Livermore Valley.

Average radioactivity levels in monthly milk samples amounted to 4 pCi/liter of cesium–137 and ≤1 pCi/liter of cesium–141 –144, for the two Livermore dairies. The average tritium concentration in milk was at or below the limit of sensitivity (5,000 pCi/liter). These levels closely correspond to those for a dairy in a neighboring valley about 25 miles from Livermore.

Site 300

The high explosive test area at Site 300 (figure 3) covers 10-square miles in the hills in a very sparsely populated ranching area about 15 miles southeast of Livermore and 8 miles southwest of Tracy. The chief area of concern for Site 300 is Tracy. The population there is about 15,000. Air and water samples are taken to determine whether operations at Site 300 are changing the normal radioactivity levels in the vicinity. The eight air samplers at Site 300 are operated at about 50 cfm on a continuous basis with the filter papers being changed on regular schedule. Most of these air samplers are located within the boundaries of the test site due to unavailability of power facilities offsite. Water samples are taken from six onsite wells because they are the only readily accessible sources of underground water. Samples are collected from streams only during the winter months when water flow exists. Soil samples are collected quarterly at nine offsite locations. Only top layer soil is collected to determine fallout concentrations. All air, water, and soil samples are processed at the laboratory in Livermore. The average radioactivity levels in samples collected are summarized in table 4.

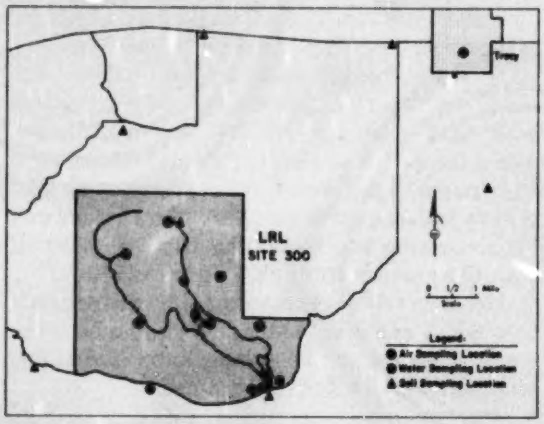

Figure 3. Sampling locations at Site 300, LRL

Table 4. Environmental sampling, LRL Site 300
January–June 1967

Type of sample (concentration units)	Average alpha radioactivity	Average beta radioactivity
Air (pCi/m³)	0.0005	0.153
Water (pCi/liter)	<5.0	4.8
Soil (pCi/g)	2	9

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–June 1966	June 1967
July–December 1966	November 1967

2. Mound Laboratory
January–June 1967 [2]

Monsanto Research Corporation
Miamisburg, Ohio

The environmental monitoring program for Mound Laboratory is planned and coordinated with all of the projects conducted at the laboratory. Air and water monitoring in the uncontrolled environs surrounding the laboratory is specific for the radionuclides which could be released to the environment. Only polonium-210, plutonium-238, and hydrogen-3 (tritium) are potential environmental contaminants.

Air monitoring

Mobile air monitoring equipment, mounted on a 1-ton panel truck, for measurement of tritium and collection of particulate alpha-particle emitters was used in the routine monitoring of environmental air in a network of 111 locations within a radius of 20 miles from the laboratory during the collection period. The choice of sites on a given day was dependent upon the wind direction at the time of collection.

Airborne polonium and plutonium particulates are collected with a high volume air sampler. The filter papers are then processed such that counting results are specific for polonium and plutonium. One fourth of each filter paper is processed by spontaneous deposition to isolate polonium. Plutonium is isolated by processing the remaining three fourths of each filter paper through a resin column.

Airborne tritium is monitored by drawing air through a calcium chloride drying tube. The water collected in the sample tube is distilled and analyzed for tritium content.

Beginning January 1, 1967, all particulate air samples collected in the same zone, in the same range, and on the same day are combined before processing and are considered as one sample. This is done to improve the lower detectable limit for plutonium.

The results of the airborne monitoring program are presented in tables 5, 6 and 7. The average concentration of plutonium, polonium, and tritium in the environment are below the AEC radiation protection standards.

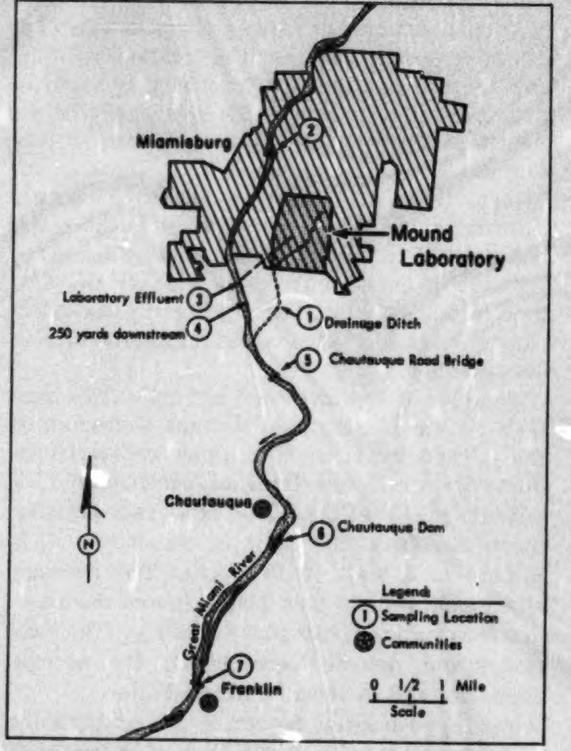

Figure 4. Water sampling locations, Mound Laboratory

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[2] Summarized from "Environmental Monitoring Report: January–June 1967" (MLM-1425).

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Table 5. Atmospheric monitoring of polonium-210 Mound Laboratory environs, January–June 1967

Range (miles)	Number of samples	Concentration [a] (pCi/m³)		Average as percent of AEC standards[b]
		Maximum	Average	
0–3 (upwind)	24	0.0466	0.0170	0.09
0–3 (downwind)	23	.1047	.0134	.07
3–5 (downwind)	24	.0533	.0169	.08
5–10 (downwind)	24	.0422	.0147	.07
10–15 (downwind)	24	.0523	.0142	.07
15–20 (downwind)	23	.0365	.0107	.05

[a] Lowest detectable level (LDL) for polonium-210 in air is 0.0060 pCi/m³ for samples collected 0–3 miles upwind, 3–5 miles downwind, 5–10 miles downwind, and 10–15 miles downwind. The LDL is 0.0053 pCi/m³ for samples collected 0–3 miles downwind and 15–20 miles downwind. All values which were not detectable were set equal to these values when average values were calculated.

[b] The applicable AEC radiation protection standard for polonium-210 in air is 20 pCi/m³.

Table 6. Atmospheric monitoring of plutonium-238 Mound Laboratory environs, January–June 1967

Range (miles)	Number of samples	Concentration (pCi/m³) [a]		Average as percent of AEC standards [b]
		Maximum	Average	
0–3 (upwind)	25	0.2832	0.0162	23.14
0–3 (downwind)	25	.1217	.0114	16.28
3–5 (downwind)	25	.0579	.0080	11.43
5–10 (downwind)	24	.0111	.0034	4.86
10–15 (downwind)	25	.0562	.0051	7.28
15–20 (downwind)	25	.0238	.0034	4.86

[a] Lowest detectable limit (LDL) for plutonium-238 in air is 0.0013 pCi/m³ for samples collected 0–3 miles upwind, 3–5 miles downwind, 5–10 miles downwind and 10–15 miles downwind. The LDL is 0.0009 pCi/m³ for samples collected 0–3 miles downwind and 15–20 miles downwind. All values which were not detectable were set equal to these values when average values were calculated.

[b] The applicable AEC radiation protection standard for plutonium-238 in air is 0.07 pCi/m³.

Table 7. Atmospheric monitoring of tritium, Mound Laboratory environs, January–June 1967

Range (miles)	Number of samples	Concentration (pCi/m³) [a]		Average as percent of AEC standards [b]
		Maximum	Average	
0–3 (upwind)	13	8.00×10^3	8.00×10^3	4.00
0–3 (downwind)	13	12.79×10^3	8.60×10^3	4.30
3–5 (downwind)	12	8.00×10^3	8.00×10^3	4.00
5–10 (downwind)	13	8.00×10^3	8.00×10^3	4.00
10–15 (downwind)	12	8.00×10^3	8.00×10^3	4.00
15–20 (downwind)	6	8.57×10^3	8.10×10^3	4.05

[a] Lowest detectable limit for tritium in air is 8×10^3 pCi/m³. All values which were not detectable were set equal to this value when average values were calculated.

[b] The applicable AEC radiation protection standard for tritium in air is 2×10^5 pCi/m³.

Water monitoring

Liquid radioactive waste materials from polonium and plutonium operations at the laboratory are processed in special waste disposal plants designed to reduce radioactivity to a concentration at which it may be discharged to the Great Miami River.

Helium–3, which is purified at the Mound Laboratory, contains small quantities of hydrogen–3 (tritium). Liquid wastes from this operation are treated separately to assure that the radioactivity level is below the AEC radiation protection standard before discharge to the Great Miami River.

Table 8. Offsite water monitoring for radioactivity, Mound Laboratory environs January–June 1967

Nuclide and sampling location [a]	Number of samples	Concentration (pCi/liter)	
		Maximum	Average [b]
Polonium-210 [c]			
2 (Upstream from laboratory)	26	4.50	1.97
3 (Laboratory effluent)	26	900.90	71.20
4 (250-yards downstream)	26	234.23	13.20
5 (Chautauqua Road Bridge)	26	3.60	1.87
6 (Chautauqua Dam)	26	3.00	1.91
7 (Franklin, Ohio)	25	1.80	1.80
Hydrogen-3 (tritium) [c]			
1 (drainage ditch)	26	0.55×10^6	0.09×10^6
2 (Upstream from laboratory)	26	0.10×10^6	0.05×10^6
3 (Laboratory effluent)	26	0.21×10^6	0.11×10^6
5 (Chautauqua Road Bridge)	26	0.07×10^6	0.05×10^6
Plutonium-238 [c]			
1 (drainage ditch)	26	945.94	73.87
2 (Upstream from laboratory)	16	22.50	6.30
3 (Laboratory effluent)	14	27.00	8.10
4 (250-yards downstream)	17	9.00	4.95
5 (Chautauqua Road Bridge)	17	22.50	6.75
6 (Chautauqua Dam)	17	9.00	4.95
7 (Franklin, Ohio)	17	54.05	7.65

[a] See figure 4 for number of sampling locations.

[b] The applicable AEC radiation protection standards for uncontrolled areas are as follows:
Polonium-210 in water: 7×10^2 pCi/liter.
Plutonium-238 in water: 5×10^3 pCi/liter.
Hydrogen-3 in water: 3×10^6 pCi/liter.

[c] Minimum detectable level for polonium-210 in water is 1.80 pCi/liter.
Minimum detectable level for hydrogen-3 in water is 0.05×10^6 pCi/liter.
Minimum detectable level for plutonium-238 in water is 4.50 pCi/liter.
All samples which were not detectable were set equal to their respective minimum detectable level when average values were calculated.

Weekly water samples are collected from a drainage ditch and six locations along the Great Miami River as shown in figure 4. Additional samples are taken quarterly at more distant downstream points. The drainage ditch carries all storm sewer water and treated liquid tritium and plutonium wastes from the plant site. Sampling location number 3 (figure 4) is the point of discharge of the liquid polonium waste to the Great Miami River, and number 7, at Franklin, Ohio, is 5 miles downstream from the effluent outfall.

All of the river samples are analyzed for polonium-210 and plutonium-238 and some of the samples are analyzed for tritium. The drainage ditch samples are analyzed for tritium and plutonium-238. Average concentrations of tritium, polonium-210, and plutonium-238 are given in table 8 for January-June 1967.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January-June 1966	May 1967
July-December 1966 and 1966 summary	November 1967

Reported Nuclear Detonations, March 1968

The Atomic Energy Commission conducted a low-yield nuclear row-charge experiment, called "Project Buggy," at its Nevada Test Site on March 12, 1968. The experiment consisted of a row of five nuclear explosives of simultaneous detonation, having a yield of about 1 kiloton each (equivalent to 1,000 tons of TNT). The explosives were buried at a depth of 135 feet and spaced 150 feet apart and produced a ditch about 80 feet deep, approximately 300 feet wide, and the length was about 900 feet. This experiment was part of the Commission's Plowshare program to develop peaceful uses of nuclear explosions.

On March 14, 1968, the U.S. Atomic Energy Commission also announced that a nuclear test of low yield (20 kilotons or less TNT equivalent) was conducted underground at its Nevada Test Site.

A nuclear test of low-intermediate yield was conducted underground (equivalent to 20 to 200 kilotons of TNT) on March 22 and a test of low yield was detonated underground March 25, 1968, at the Nevada Test Site.

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French Nuclear Weapons Tests, July–October 1966 and June–July 1967[1]

The first series of five nuclear weapons tests by France were conducted in the islands of Tuamotu Archipelago in the South Pacific Ocean from July to October 1966. Explosion 1, held July 2, 1966, was a plutonium fission device fired over the lagoon at Mururoa Island with an estimated yield of 25 to 30 kilotons TNT equivalent. Explosion 2 on July 19th was a plutonium fission device released from an aircraft and exploded in the lower atmosphere with an estimated yield of 70 to 80 kilotons TNT equivalent. On the 11th of September, the third explosion was of the same type as the first, with a yield of about 120 kilotons TNT equivalent. The two concluding explosions were of higher yields and apparently involved thermonuclear reactions; explosion 4, September 24, was an experimental device utilizing plutonium and thermonuclear materials exploded over the lagoon at Fangataufa Island with an estimated yield of about 150 kilotons TNT equivalent. Explosion 5, held on October 4th was the same as explosion 4; however, it was exploded over the lagoon at Mururoa Island with an estimated yield of 200 to 300 kilotons TNT equivalent. The above information on the tests was drawn largely from the Paris press as no official statement has been made on the actual yields of the explosions (*1*).

The second series of tests at the site were carried out in June and July 1967. The following information on the tests was given in official statements released by the French Government. There were three explosions held; June 5, June 27, and July 2, 1967, respectively. All three explosions were above the lagoon at Mururoa Island, and the weapons, described as experimental devices of low yield, were supported on balloons (*2*). "Low yield" is defined by the U.S. Atomic Energy Commission as being less than 20 kilotons TNT equivalent.

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(*1*) GIBBS, W. J., J. R. MORONEY, D. J. STEVENS, and E. W. TITTERTON. Fallout over Australia from nuclear weapons tested by France in Polynesia from July to October 1966. Australian J Sci 29:407–417 (November 1967).

(*2*) GIBBS, W. J., J. R. MORONEY, D. J. STEVENS, and E. W. TITTERTON. Fallout over Australia from nuclear weapons tested by France in Polynesia during June and July 1967. Australian J Sci 30:217–226 (December 1967).

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[1] G.m.t., Greenwich mean time for actual dates listed.

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SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

SUMMARY OF IRON–55 CONTAMINATION IN THE ENVIRONMENT AND LEVELS IN HUMANS. *Warren A. Brill, Radiological Health Data and Reports, Vol. 8*, April 1967, pp. 195–201.

Levels of iron–55 in the environment and in food sources have been summarized. The average body burdens and resulting doses to the erythrocytes (red blood cells) of selected Alaskan Eskimos, and residents of the States of Washington, New York, and New Jersey are compared. Considering the erythrocytes as the critical organ, the dose rate from 1 pCi iron–55/mg stable iron is 0.095 mrad/yr. A body burden of 8 nCi, the average for Richland, Wash., residents, yields a yearly dose of 0.19 mrad, while 1,100 nCi, the average body burden for Eskimos on fish diets, yields a yearly dose of 26 mrad.

KEY WORDS: body burdens, blood dose, environment, erythrocytes dose, Eskimos, fallout, food chain, iron–55, marine organisms, U.S. regions.

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RADIOLOGICAL HEALTH DATA AND REPORTS

Volume 9, Number 5 May 1968

In August 1959, the President directed the Secretary of Health, Education, and Welfare, to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collection, analysis, and interpretation of data on environmental radiation levels such as natural background, radiography, medical and industrial uses of isotopes and X rays, and fallout. The Department delegated this responsibility to the National Center for Radiological Health, Public Health Service.

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Data

SECTION I. MILK AND FOOD

In the determination of the internal exposure to man from environmental radiation sources, primary interest centers on radionuclides in the diet. Federal and State agencies are involved in efforts to monitor continuously the dietary intake of radionuclides. The most direct measure of radionuclide intake would be obtained through radioanalysis of the total diet. Difficulties in obtaining specific dietary data impede this approach. An alternate method entails the use of indicator foods to arrive at an estimate of the total dietary radionuclide intake.

Fresh milk is one such indicator food. It is consumed by a large segment of the U.S. population and contains most of the biologically significant radionuclides which appear in the diet. It is also one of the major sources of dietary intake for the short-lived radionuclides. For these reasons, fresh milk is the single food item most often used in estimating the intake of selected radionuclides by the general population and/or specific population groups. In the absence of specific dietary information, it is possible to approximate the total daily dietary intake of selected radionuclides as being equivalent to the intake represented by the consumption of 1 liter of fresh milk.

The Federal Radiation Council (FRC) has developed Radiation Protection Guides (RPG's) for controlling normal peacetime nuclear operations, assuming continuous exposure from intake by the population at large (*1–3*). The RPG's do not and cannot establish a line which is safe on one side and unsafe on the other; they do provide an indication of when there is a need to initiate careful evaluation of exposure (*3*). Additional guidelines are provided by the FRC Protective Action Guides (*4*) and by the International Commission on Radiological Protection (*5, 6*).

Data from selected national, international, and State milk and food surveillance activities are presented herein. An effort has been made to present a cross-section of routine sampling programs which may be considered of a continuing nature. Routine milk sampling has been defined as one or more samples collected per month.

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National and International Milk Surveillance

As part of continuing efforts to quantitatively monitor man's exposure to radionuclides, various national and international organizations routinely monitor radionuclide levels in milk. In addition to those programs reported below, *Radiological Health Data and Reports* coverage includes:

Program	Period reported	Last presented
Radiostrontium in milk, HASL	July–December 1966	September 1967

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1. Pasteurized Milk Network
January 1968

National Center for Radiological Health and *National Center for Urban and Industrial Health, PHS*

The Public Health Service's Pasteurized Milk Network (PMN) is designed to provide nationwide surveillance of radionuclide concentrations in milk through sampling from major milk production and consumption areas. The present network of 63 stations (figure 1) provides data on milk in every State, Washington, D.C., the Canal Zone and Puerto Rico. The most recent description of the sampling and analytical procedures employed by the PMN

Table 1. Analytical errors associated with determinations of radionuclide concentrations in a milk sample

Nuclide	Concentration (pCi/liter)	Error [a] (pCi/liter)	Concentration (pCi/liter)	Error [a] (percent of concentration)
Strontium-89	<50	5	≥50	10
Strontium-90	<20	2	≥20	10
Iodine-131	<100	10	≥100	10
Cesium-137	<100	10	≥100	10
Barium-140	<100	10	≥100	10

[a] Two standard deviations.

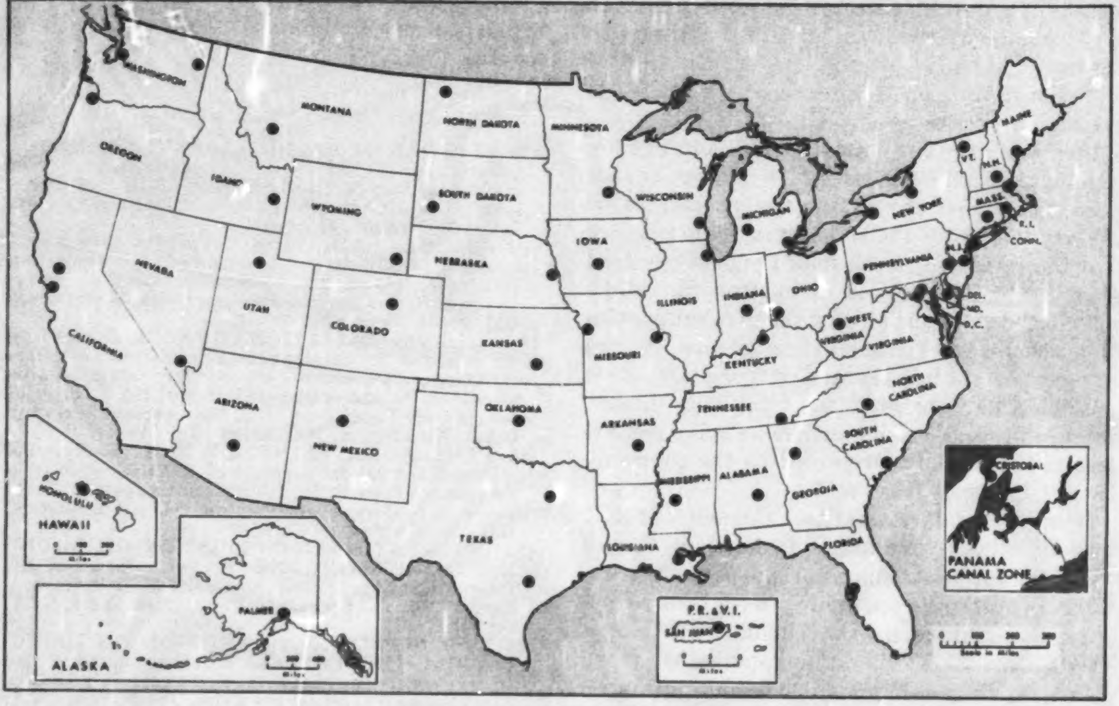
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Figure 1. Pasteurized Milk Network sampling stations

Table 2. Average concentrations of radionuclides in milk for January 1968 and the 12-month period, February 1967–January 1968

Sample location		Radionuclide concentration (pCi/liter)									
		Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
		Feb 1967-Jan 1968	Jan 1968	Feb 1967-Jan 1968	Jan 1968	Feb 1967-Jan 1968	Jan 1968	Feb 1967-Jan 1968	Jan 1968	Feb 1967-Jan 1968	Jan 1968
Ala:	Montgomery	0	0	10	8	0	0	14	9	0	0
Alaska:	Palmer	0	0	7	5	0	0	19	12	1	8
Ariz:	Phoenix	0	0	1	0	0	0	1	0	0	0
Ark:	Little Rock	0	0	22	17	0	0	19	15	0	0
Calif:	Sacramento	2	0	2	6	0	0	5	8	0	0
	San Francisco	2	0	3	1	0	0	3	12	1	6
C. Z:	Cristobal	0	0	4	2	0	0	19	13	0	2
Colo:	Denver	1	0	6	5	1	0	5	5	0	0
Conn:	Hartford	NA	NA	10	11	0	0	18	12	0	0
Del:	Wilmington	NA	NA	11	13	0	0	13	5	0	0
D.C:	Washington	0	0	10	9	0	0	9	0	0	0
Fla:	Tampa	0	0	8	9	0	0	74	50	0	0
Ga:	Atlanta	0	0	15	13	0	0	23	17	0	0
Hawaii:	Honolulu	0	1	4	2	1	0	8	4	2	0
Idaho:	Idaho Falls	1	0	6	5	0	0	8	10	0	0
Ill:	Chicago	0	0	9	11	0	0	14	12	0	0
Ind:	Indianapolis	NA	NA	8	6	0	0	10	15	0	0
Iowa:	Des Moines	1	0	8	5	0	0	7	10	0	0
Kans:	Wichita	1	0	9	12	0	0	4	4	0	0
Ky:	Louisville	0	0	13	10	0	0	7	0	1	0
La:	New Orleans	1	0	24	21	0	0	27	15	0	0
Maine:	Portland	NA	NA	12	11	0	0	35	24	0	0
Md:	Baltimore	0	0	11	9	0	0	10	0	0	0
Mass:	Boston	0	0	12	9	0	0	20	20	0	0
Mich:	Detroit	NA	NA	9	9	0	0	14	10	0	0
	Grand Rapids	NA	NA	10	12	0	0	18	14	0	0
Minn:	Minneapolis	1	0	13	11	0	0	13	9	0	0
Miss:	Jackson	1	0	18	15	0	0	16	8	0	0
Mo:	Kansas City	2	3	9	2	0	0	3	4	1	0
	St. Louis	2	0	10	2	0	0	7	12	0	2
Mont:	Helena	1	0	6	6	0	0	8	5	0	0
Nebr:	Omaha	0	3	8	6	0	0	5	5	0	2
Nev:	Las Vegas	0	0	2	2	0	0	3	15	0	0
N.H:	Manchester	NA	NA	14	14	0	0	42	30	0	0
N.J:	Trenton	NA	NA	10	9	0	0	14	6	0	0
N. Mex:	Albuquerque	0	0	3	2	0	0	2	3	0	2
N. Y:	Buffalo	NA	NA	9	10	0	0	14	11	0	0
	New York	NA	NA	11	11	0	0	15	5	0	0
	Syracuse [a]	NA	NA	8	0	0		14		0	
N. C:	Charlotte	0	0	17	16	1	9	16	13	1	0
N. Dak:	Minot	3	0	14	11	0	0	13	11	0	0
Ohio:	Cincinnati	NA	NA	10	10	0	0	9	5	0	0
	Cleveland	NA	NA	10	9	0	0	13	6	0	0
Okla:	Oklahoma City	0	0	10	8	0	0	5	6	0	0
Ore:	Portland	1	0	8	5	1	0	13	14	0	0
Pa:	Philadelphia	NA	NA	10	10	0	0	12	11	0	0
	Pittsburgh	NA	NA	13	13	0	0	18	12	0	0
P. R:	San Juan	1	0	5	4	0	0	13	9	0	0
R. I:	Providence	NA	NA	11	9	0	0	24	15	0	0
S. C:	Charleston	0	0	16	14	0	3	31	25	0	0
S. Dak:	Rapid City	2	0	12	10	0	0	11	15	0	0
Tenn:	Chattanooga	0	0	16	12	0	0	16	15	0	0
	Memphis	0	0	13	9	0	0	5	0	0	0
Tex:	Austin	0	0	4	4	0	0	4	0	0	0
	Dallas	0	0	9	7	0	0	6	0	0	0
Utah:	Salt Lake City	0	0	6	6	0	0	11	14	0	0
Va:	Norfolk	0	0	10	10	1	0	17	3	0	0
Vt:	Burlington	NA	NA	12	10	0	0	12	12	0	0
Wash:	Seattle	2	2	11	8	0	0	26	14	0	0
	Spokane	1	4	10	6	0	0	16	3	0	0
W. Va:	Charleston	0	0	11	9	0	0	7	3	0	0
Wisc:	Milwaukee	NA	NA	8	15	0	0	15	15	0	0
Wyo:	Laramie	0	0	5	5	0	0	5	12	0	0
Network monthly average		0	0	10	9	0	0	14	10	0	0

[a] 12-month averages represent only 10 months' data.
NA, no analysis for period reported.

appeared in the January 1968 issue of *Radiological Health Data and Reports* (*1*). Reference should also be made to the February 1968 issue (*2*), in which several changes in the interpretation and reporting of data were introduced.

Table 1 shows the approximate analytical errors (including counting error) associated with determinations of radionuclide concentrations in milk. These errors were determined by comparing results of a large number of replicate analyses. Table 2 contains averages for January 1968 and 12-month averages for the period February 1967 through January 1968. The 12-month average enables evaluations of population exposure with respect to the guidance provided by the Federal Radiation Council. This suggests average total daily intakes, averaged over periods "of the order of a year," as an appropriate criterion (*3*). The average radionuclide concentrations are based on results obtained from samples collected weekly. Whenever weekly concentrations were less than or equal to the appropriate minimum detectable levels, zero was used for averaging purposes (*3*). At very low radionuclide concentrations this often results in averages lower than the minimum detectable concentration for a single sample, but any positive value reflects at least one weekly sample which was above the minimum detectable level. The minimum detectable concentration is defined as the measured concentration equal to the two-standard deviation analytical error. Accordingly, the minimum detectable concentrations in units of pCi/liter are: strontium–89, 5; strontium–90, 2; iodine–131, cesium–137, and barium–140, 10.

The average strontium–90 concentrations in pasteurized milk from selected cities are presented in figure 2.

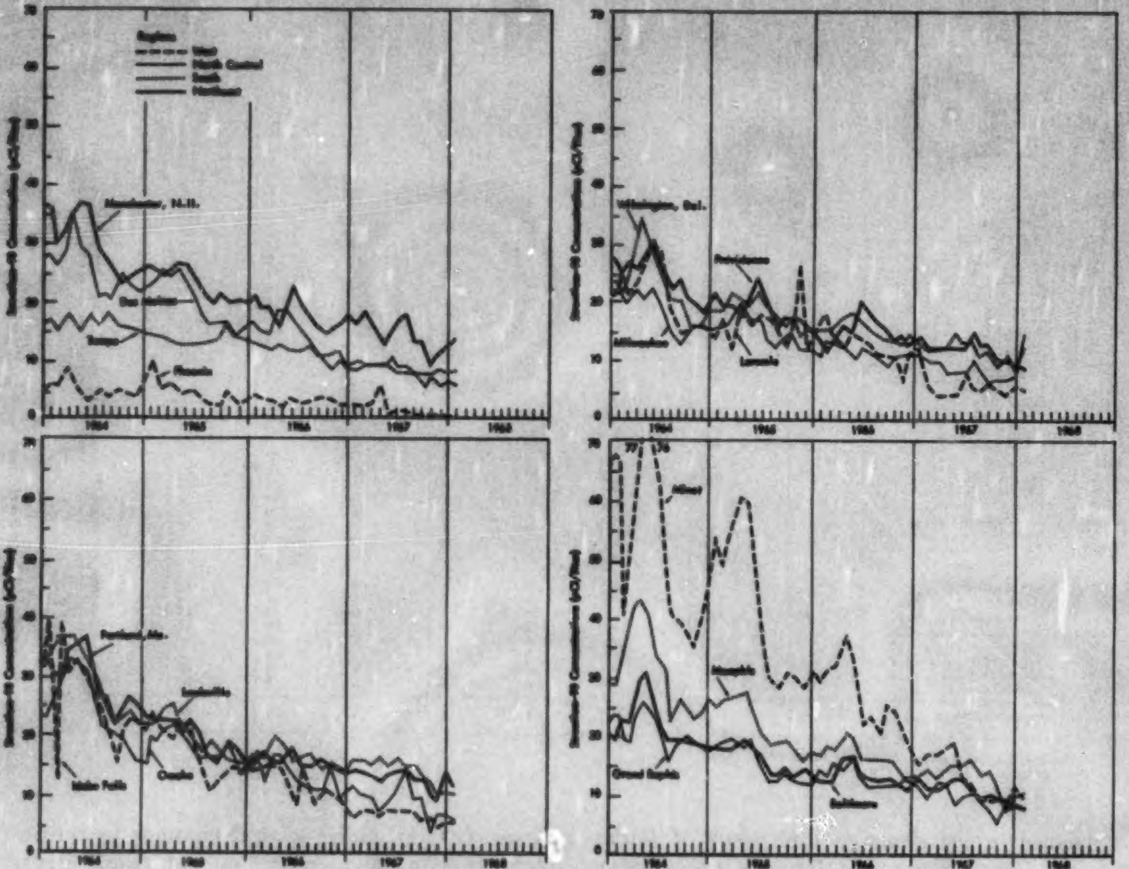

Figure 2. Strontium–90 concentrations in pasteurized milk, 1964–January 1968

2. Canadian Milk Network[1]
January 1968

Radiation Protection Division
Department of National Health and Welfare

Since November 1955, the Radiation Protection Division of the Department of National Health and Welfare has been monitoring milk for radionuclide concentrations. Powdered milk was originally sampled, but liquid whole milk has been sampled since January 1963. At present, 16 milk sampling stations (figure 3) are in operation. Their locations coincide with air and precipitation sampling stations.

Milk samples are collected three times a week from selected dairies and are combined into weekly composites. The contribution of each dairy to the composite sample is directly proportional to the liquid volume of sales. Weekly spot check analyses are made for iodine–131, and monthly composites are analyzed for strontium–90, cesium–137, and stable calcium and potassium. The analytical procedures were outlined in the April 1968 issue of *Radiological Health Data and Reports* (4).

The January 1968 monthly average strontium–90, cesium–137, stable calcium and potassium concentrations in Canadian whole milk are presented in table 3. Iodine–131 and strontium–89 concentrations were below minimum detectable levels.

Table 3. Stable elements and radionuclides in Canadian whole milk, January 1968

Station	Calcium (g/liter)	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Calgary	1.13	1.5	8	22
Edmonton	1.06	1.4	8	21
Ft. William	1.12	1.4	16	24
Fredericton	1.09	1.4	9	19
Halifax	1.13	1.5	13	22
Montreal	1.13	1.6	10	19
Ottawa	1.10	1.6	10	17
Quebec	1.06	1.5	13	26
Regina	1.04	1.4	6	15
St. John's Nfld	1.15	1.6	15	39
Saskatoon	1.12	1.5	10	16
Sault Ste. Marie	1.14	1.6	16	28
Toronto	1.10	1.4	6	16
Vancouver	1.24	1.6	14	52
Windsor	1.17	1.6	6	14
Winnipeg	1.12	1.5	8	24
Average	1.12	1.5	11	23

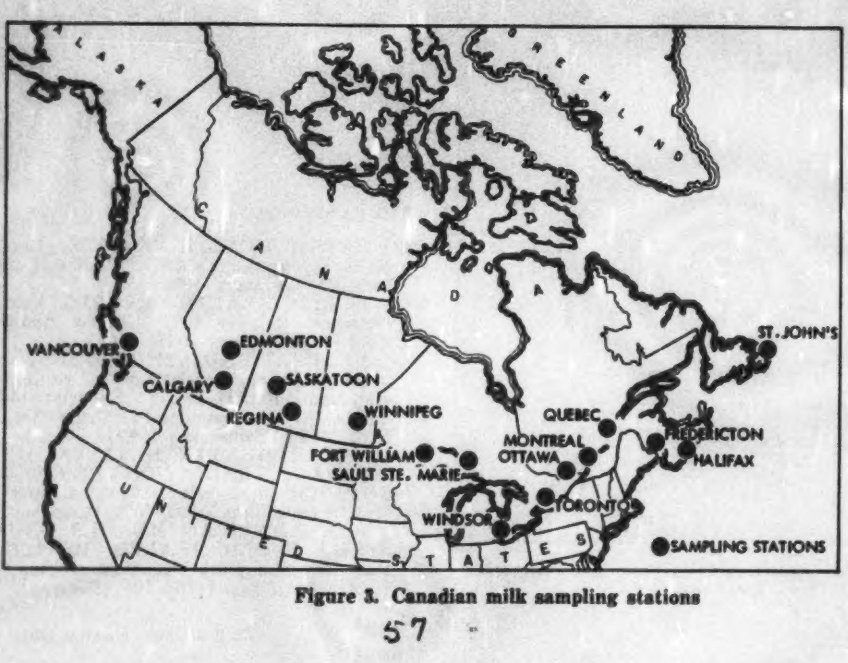

Figure 3. Canadian milk sampling stations

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[1] Prepared from February 1968 monthly report, "Data from Radiation Protection Programs," Canadian Department of National Health and Welfare, Ottawa, Canada.

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3. Pan American Milk Sampling Program January 1968

Pan American Health Organization and *U.S. Public Health Service*

The Pan American Health Organization (PAHO) in collaboration with the U.S. Public Health Service (PHS), furnishes assistance to health agencies in the American republics in developing national radiological health programs.

Under a joint agreement between agencies, air and milk sampling activities are conducted by a number of PAHO member countries (figure 4). Results of the milk sampling program are presented below. Further information on the sampling and analytical procedures employed was presented in the December 1966 issue of *Radiological Health Data and Reports* (*5*).

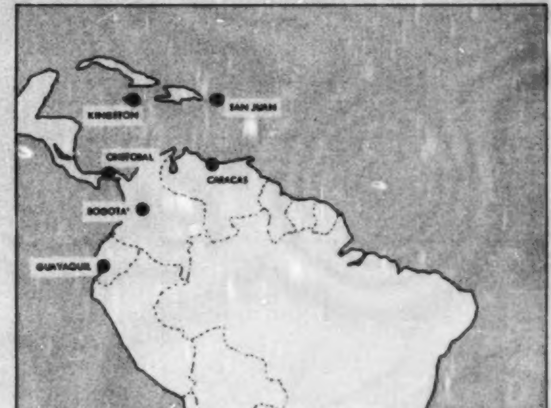

Figure 4. Pan American Milk Sampling Program locations

Table 4 presents stable potassium, strontium-90 and cesium-137 monthly concentrations for January 1968.

Table 4. Stable element and radionuclide concentrations in Pan American milk [a]

Sampling stations		Number of samples	Potassium g/liter	Strontium-90 [b] (pCi/liter)	Cesium-137 [b] (pCi/liter)
Chile:	Santiago	1	1.6	0	0
Colombia:	Bogota	1	1.5	0	0
Ecuador:	Guayaquil	1	1.4	0	0
Jamaica:	Kingston	1	1.4	0	60
Venezuela:	Caracas	1	1.5	0	0
Canal Zone:	Cristobal [c]	5	1.5	2	15
Puerto Rico:	San Juan [c]	4	1.6	4	11

[a] Strontium-89 was less than 5 pCi/liter and iodine-131 and barium-140 were less than 10 pCi/liter.

[b] The reporting levels for analyses of single samples of strontium-90 and cesium-137 have been changed to conform with current practice in the PMN. Strontium-90 analyses results ≦ 2 pCi/liter and cesium-137 results ≦ 10 pCi/liter are reported as 0.

[c] For comparison, the radionuclide concentrations at Cristobal, Canal Zone, and San Juan, Puerto Rico, from the Pasteurized Milk Network are presented.

REFERENCES

(*1*) PUBLIC HEALTH SERVICE. Pasteurized Milk Network, September 1967. Radiol Health Data Rep 9:20–23 (January 1968).

(*2*) PUBLIC HEALTH SERVICE. Pasteurized Milk Network, October 1967. Radiol Health Data Rep 9:86–89 (February 1968).

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1960).

(*4*) DEPARTMENT OF NATIONAL HEALTH AND WELFARE, RADIATION PROTECTION DIVISION. Canadian milk network, August 1966. Radiol Health Data Rep 7:702–703 (December 1966).

(*5*) PAN AMERICAN HEALTH ORGANIZATION and U.S. PUBLIC HEALTH SERVICE. Pan American Milk Sampling Program, August 1966. Radiol Health Data Rep 7:704–705 (December 1966).

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State Milk Surveillance Activities

Considerable progress has been made by the State health departments in initiating or expanding environmental surveillance activities in radiological health. Many of the States now have comprehensive environmental surveillance programs and self-sustaining radiological health laboratories.

The continuing efforts of State health departments in the analysis and monitoring of radionuclides in milk complement Federal milk surveillance activities. State milk surveillance activities are continually undergoing developmental changes. The results presented herein are representative of current surveillance activities directed at the use of milk as an indicator of dietary intake of radioactivity.

Figure 1 shows the States which report milk surveillance activities in *Radiological Health Data and Reports*. States having programs appearing in this issue are highlighted in the figure. Following is a summary of previously covered State programs, their reporting period, and issue of appearance.

State milk network	Period reported	Last presented
California	July–September 1967	March 1968
Colorado	October–December 1967	April 1968
Florida	October–December 1967	April 1968
Oklahoma	October–December 1967	April 1968
Oregon	July–September 1967	March 1968
Tennessee	October–December 1967	April 1968
Texas	October–December 1967	April 1968
Washington	July–September 1967	March 1968

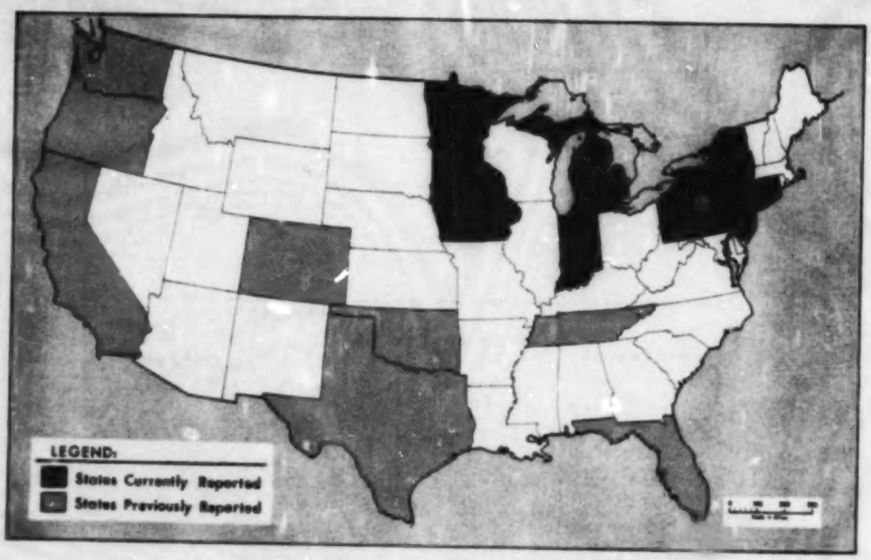

Figure 1. State milk surveillance activities

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1. Connecticut Milk Network October–December 1967

Connecticut State Department of Health

The Connecticut State Department of Health has been monitoring pasteurized milk for strontium–89 and strontium–90 since April 1960. In May 1962, the program was expanded to include the determination of gamma emmitting radionuclides in milk.

The sampling program is flexible in nature, providing for sampling in five areas of the State (figure 2). At the present time, weekly samples representative of milk sold in the central area of the State are collected and analyzed for strontium–89, strontium–90, and gamma-ray emitters. Concentrations of iodine–131 are determined as an indication of the presence of radioactivity of recent origin.

Strontium–89 and strontium–90 are determined by chemical separation. Iodine–131 and other gamma-ray emitters are determined by gamma-ray scintillation spectroscopy.

The monthly average concentrations of strontium–90, iodine–131, and cesium–137 in central Connecticut pasteurized milk are presented in table 1. These results are presented graphically in figure 3. Strontium–89 and iodine–131 were below detectable levels.

Table 1. Radionuclide concentrations in central Connecticut pasteurized milk, October–December 1967

Month (1967)	Radionuclide concentration (pCi/liter)	
	Strontium-90	Cesium-137
October	7	10
November	8	10
December	8	10

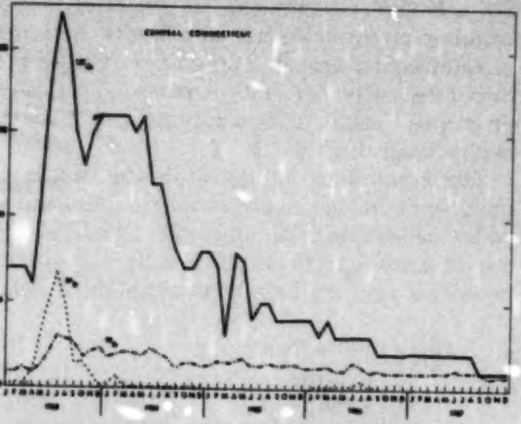

Figure 3. Radionuclide concentrations in central Connecticut pasteurized milk, 1962–December 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	November 1967
July–September 1967	February 1968

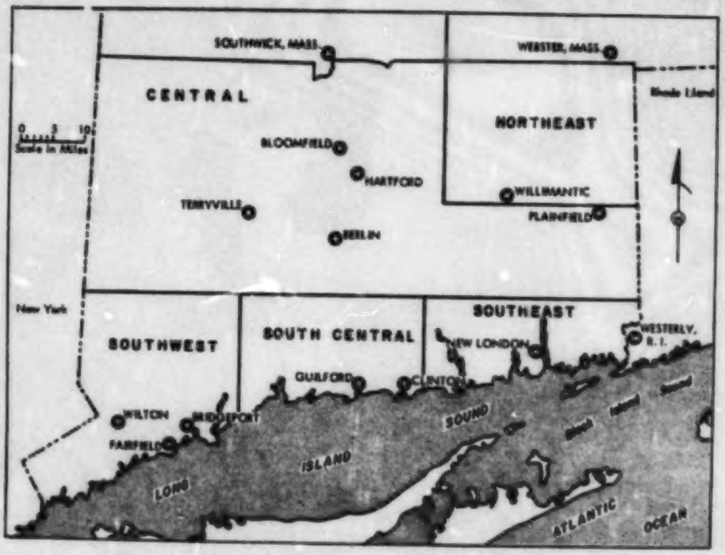
SOUTHWICK, MASS.
WEBSTER, MASS.
CENTRAL
NORTHEAST
Rhode Island
0 5 10
Scale in Miles
BLOOMFIELD
HARTFORD
TERRYVILLE
BERLIN
WILLIMANTIC
PLAINFIELD
New York
SOUTHWEST
SOUTH CENTRAL
SOUTHEAST
NEW LONDON
WESTERLY, R.I.
GUILFORD
CLINTON
WILTON
BRIDGEPORT
FAIRFIELD
LONG ISLAND SOUND
Block Island Sound
ATLANTIC OCEAN

Figure 2. Connecticut pasteurized milk sampling areas

2. Indiana Milk Network
October–December 1967

Bureau of Environmental Sanitation
Indiana State Board of Health

The Indiana State Board of Health began sampling pasteurized milk for radionuclide analysis in September 1961. The State was geographically divided into five major milksheds; northeast, northwest, central, southeast, and southwest (figure 4). One large dairy within each milkshed was assumed to be representative for sampling purposes.

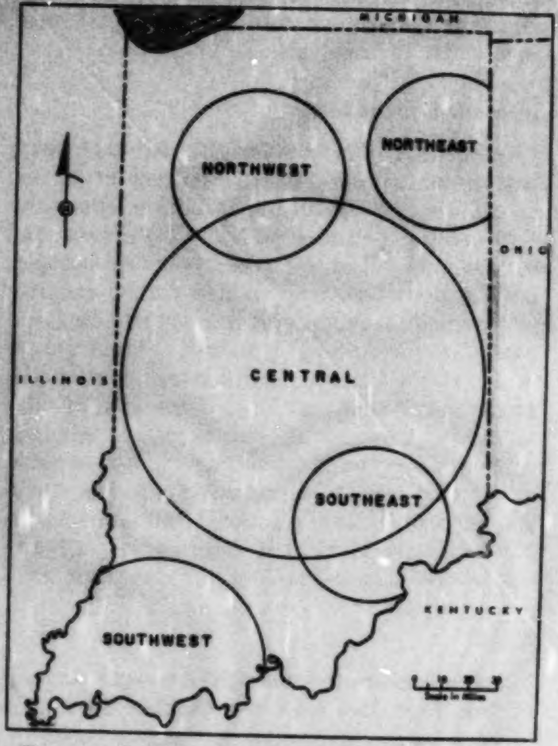

Figure 4. Indiana pasteurized milk sampling areas

The milk samples are analyzed monthly for strontium-89 and strontium-90. Cesium-137, iodine-131, and barium-140 are analyzed weekly for at least two of the milksheds. When iodine-131 concentrations exceed 100 pCi/liter, the sampling frequency is increased. From August 1963 to April 1966, because of the continued low concentrations of short-lived radionuclides, the sampling frequency was once a month for the northeast, southeast, and southwest milksheds.

Strontium-89 and strontium-90 concentrations in milk samples are determined by ion exchange separation (*1, 2*) while cesium-137, iodine-131, and barium-140 are determined by gamma-ray scintillation spectrometry (*3*).

The monthly stable element and radionuclide concentrations in Indiana pasteurized milk are presented by sampling locations in table 2 for October through December 1967. Barium-140 and iodine-131 concentrations remained below detectable levels of 10 pCi/liter during this period.

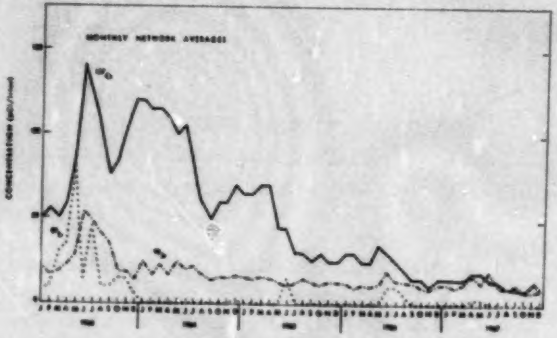

Figure 5. Radionuclide concentrations in Indiana pasteurized milk, 1963–March 1967

Table 2. Stable element and radionuclide concentrations in Indiana milk [a]
October–December 1967

Sampling location	Calcium (g/liter)			Potassium-40 (pCi/liter)			Strontium-90 (pCi/liter)			Cesium-137 (pCi/liter)		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
Northeast	1.04	1.37	1.19	1,280	1,380	1,310	8	10	8	15	5	5
Southeast	1.00	1.31	1.17	1,290	1,460	1,350	10	8	9	5	5	15
Central	1.05	1.26	1.25	1,340	1,370	1,280	7	8	6	15	15	10
Southwest	0.87	1.28	1.20	1,160	1,350	1,380	10	10	11	10	10	15
Northwest	.99	1.20	1.28	1,280	1,390	1,300	8	9	10	10	15	10
Average	0.99	1.28	1.21	1,270	1,390	1,320	9	9	10	10	15	10

[a] Stronium-89 concentrations were nondetectable and reported as zero.

The monthly network average concentrations of strontium–89, strontium–90, and cesium–137 are presented graphically in figure 5.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	November 1967
July–September 1967	February 1968

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3. Iowa Milk Network
October–December 1967

State Hygienic Laboratory and the Iowa State Department of Health

In Iowa, radiological health activities are conducted jointly by the State Department of Health and the State Hygenic Laboratory, with the State Hygienic Laboratory performing the surveillance and analytical functions.

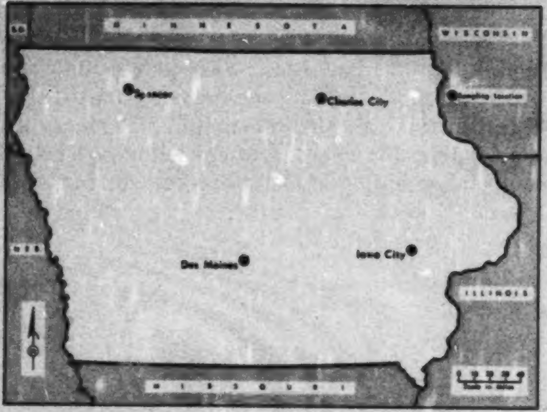

Figure 6. Iowa milk sampling locations

In August 1962 the State Hygienic Laboratory of Iowa began sampling milk for iodine–131. In May 1964 this routine surveillance was expanded to include cesium–137 and strontium–90.

One gallon samples are collected from 4 stations, selected to give a broad coverage of milk production areas in the State (figure 6). Producers furnishing milk to the Spencer bottling area are quite restricted to that northwest part of the State and the majority of milk bottled in Iowa City comes from six counties in east central Iowa. The Des Moines milkshed comprises approximately sixty counties covering about two thirds of the State radiating out of Des Moines in all directions. The Charles City bottling area covers primarily north central Iowa. At present the Iowa City and Des Moines stations are sampled weekly and the Spencer and Charles City stations are sampled monthly. This sampling frequency is increased when nuclide concentrations warrant closer surveillance. The samples are forwarded to the State Hygienic Laboratory at the University of Iowa, Iowa City, for analysis.

Analytical procedures

Iodine–131 and cesium–137 together with barium-lanthanum–140 and potassium–40 are determined by gamma-scintillation spectrometry using a 4- by 4-inch NaI (Tl) crystal and 512 channel pulse height analyzer. All samples are 3.5 liters and are counted for 80 minutes in Marinelli beakers with the results being calculated using a 4 by 4 matrix. Strontium–90 is determined by an ion-exchange system described by Porter, *et al* (4). One liter of milk is passed through an ion exchange column; yttrium–90 is eluted from the resin and counted as yttrium oxalate in an automatic low background proportional counter. Minimum detectable limits are 10 pCi/liter for iodine–131 and cesium–137 and 2 pCi/liter for strontium–90.

Results

Table 3 gives the monthly averages at each of the four locations for October–December

Table 3. Radionuclide concentrations in Iowa milk October–December 1967

Sampling location	Radionuclide concentration (pCi/liter)								
	Strontium–90			Cesium–137			Iodine–131		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
Iowa City	7	6	8	<10	<10	<10	<10	<10	<10
Des Moines	7	8	9	<10	12	10	<10	<10	<10
Spencer	12	NA	8	<10	12	12	<10	<10	<10
Charles City	NA	NA	NA	NA	NA	NA	NA	NA	NA
Average	9	7	8	<10	11	11	<10	< 10	<10

NA, no analysis.

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1967 and figure 7 shows graphically the overall network average monthly results for the same period. During this period it can be seen that the concentration levels of cesium-137 and strontium-90 showed a decreasing trend. Except for the month of June 1965, iodine-131 has not been detected in any significant quantities.

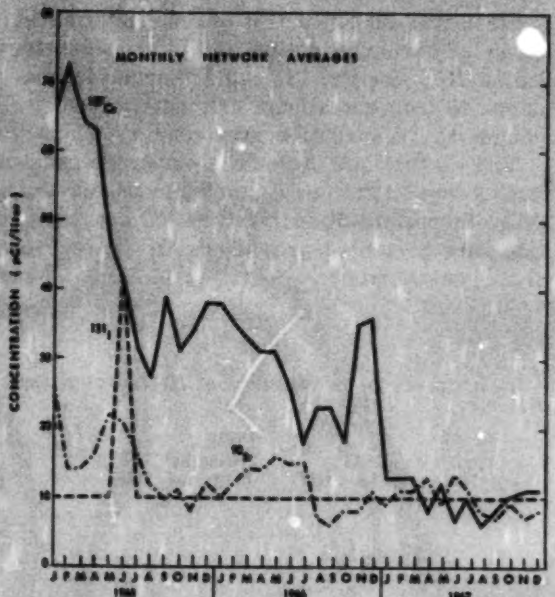

Figure 7. Radionuclide concentrations in Iowa milk January 1965–December 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	November 1967
July–September 1967	February 1968

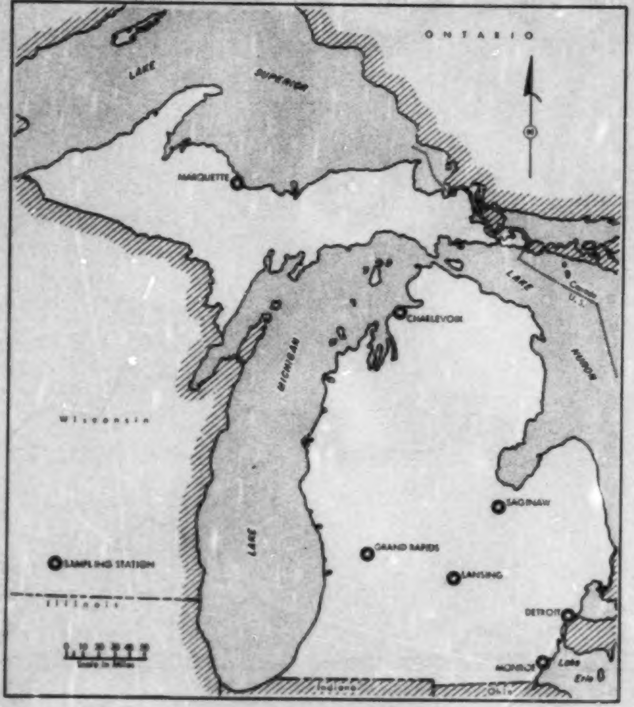
ONTARIO
LAKE SUPERIOR
MARQUETTE
CHARLEVOIX
LAKE MICHIGAN
LAKE HURON
Canada
U.S.
Wisconsin
Illinois
Indiana
Ohio
SAGINAW
GRAND RAPIDS
LANSING
DETROIT
MONROE
Lake Erie
SAMPLING STATION
Scale in Miles

Figure 8. Michigan pasteurized milk network sampling locations

4. Michigan Milk Network
October–December 1967

Division of Occupational Health
Michigan Department of Health

The Michigan Department of Health began sampling pasteurized milk for radionuclide analyses in November 1962. Under this program, weekly pasteurized milk samples are collected in the seven major milk producing areas in the State: Charlevoix, Detroit, Grand Rapids, Lansing, Marquette, Monroe, and Saginaw (figure 8). Milkshed samples are composites of dairies in proportion to sales volumes.

Strontium-90 concentrations are determined by an ion exchange method (*5*). Potassium-40, iodine-131, cesium-137, and barium-lanthanum-140 concentrations are determined by gamma-ray scintillation spectrometry (*5*).

Table 4 presents the monthly average radionuclide concentrations in Michigan pasteurized milk. Strontium-90 and cesium-137 concentrations are presented graphically in figure 9 to show general trends.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	November 1967
July–September 1967	February 1968

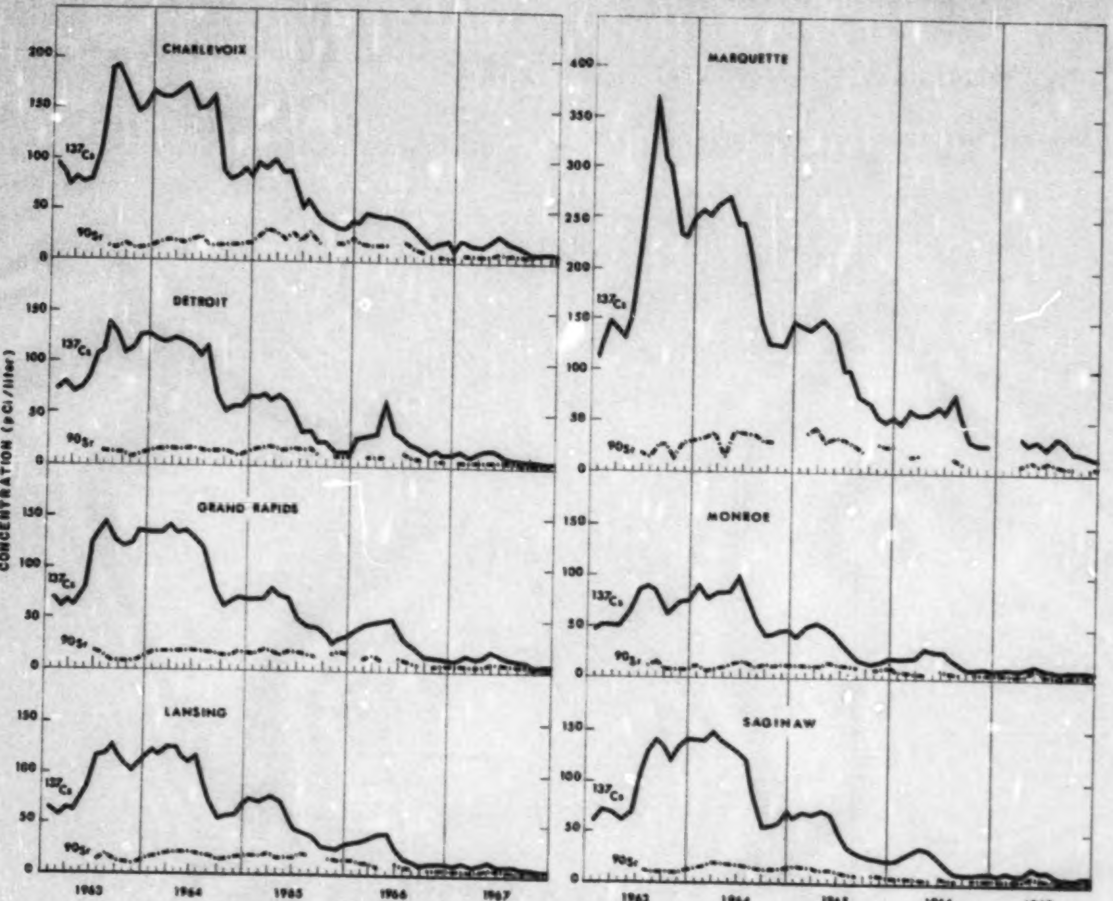

Figure 9. Radionuclide concentrations in Michigan pasteurized milk, 1963–December 1967

Table 4. Radionuclide concentrations in Michigan pasteurized milk, October–December 1967

Sampling location	Month	Radionuclide concentration (pCi/liter)			
		Potassium-40	Strontium-90	Iodine-131	Cesium-137
Charlevoix	October	1,320	NA	<14	8
	November	1,320	4	<14	9
	December	1,340	6	<14	8
Detroit	October	1,310	4	<14	7
	November	1,310	4	<14	5
	December	1,360	NA	<14	6
Grand Rapids	October	1,320	5	<14	6
	November	1,350	5	<14	9
	December	1,380	4	<14	9
Lansing	October	1,300	4	<14	7
	November	1,350	4	<14	6
	December	1,340	4	<14	8
Marquette	October	1,320	NA	<14	19
	November	1,300	6	<14	16
	December	1,300	7	<14	14
Monroe	October	1,320	3	<14	5
	November	1,300	5	<14	8
	December	1,350	3	<14	6
Saginaw Bay City ᵃ	October	1,260	5	<14	6
	November	1,330	3	<14	8
	December	1,330	3	<14	8
Average	October	1,310	4	<14	8
	November	1,340	4	<14	9
	December	1,350	5	<14	8

ᵃ Saginaw sample discontinued in October 1967. Bay City samples started in November 1967.
NA, no analysis.

5. Minnesota Milk Network
October–December 1967

Division of Environmental Health
Minnesota Department of Health

In September 1958, the Minnesota Department of Health initiated a pasteurized milk network to monitor strontium-90 concentrations. Monitoring of iodine-131 concentrations commenced in October 1961 and of cesium-137 concentrations in July 1963. Until recently, one-liter samples were collected from eight sampling locations in milksheds geographically the same as the Minnesota health districts (figure 10) and analyzed for strontium-90, iodine-131, and cesium-137. The size of the sample has been increased to 2 quarts for more accurate determinations. The 2-quart samples of processed Grade A fluid milk are collected in the cities where the Minnesota Health Department district offices are located.

Strontium-90 concentrations are determined radiochemically, while iodine-131 and cesium-137 concentrations are determined by gamma ray scintillation spectrometry. The analytical procedures are presented in the semiannual report of the Minnesota Department of Health and the Rural Cooperative Power Association (*6*).

Strontium-90, and cesium-137 concentrations in milk are given for October through December 1967 in table 5, and are presented graphically by milkshed in figure 11 for the period 1963 through December 1967. Iodine-131 concentrations were less than 10 pCi/liter in all 24 samples.

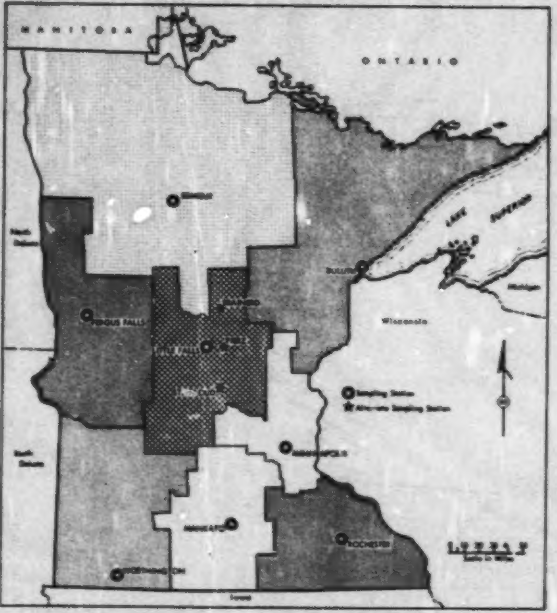

Figure 10. Minnesota milk sampling locations

Table 5. Radionuclide concentrations in Minnesota pasteurized milk, October–December 196.

Station	Radionuclide concentration (pCi/liter)					
	Strontium-90			Cesium-137		
	Oct	Nov	Dec	Oct	Nov	Dec
Bemidji	14	12	15	21	14	22
Mankato	8	5	6	9	7	6
Rochester	9	6	8	9	6	3
Duluth	16	19	16	22	16	21
Worthington	6	6	5	8	2	4
Minneapolis	13	10	9	8	5	6
Fergus Falls	12	6	7	12	11	5
Little Falls	10	8	7	14	10	9
Average	11	9	9	13	9	9

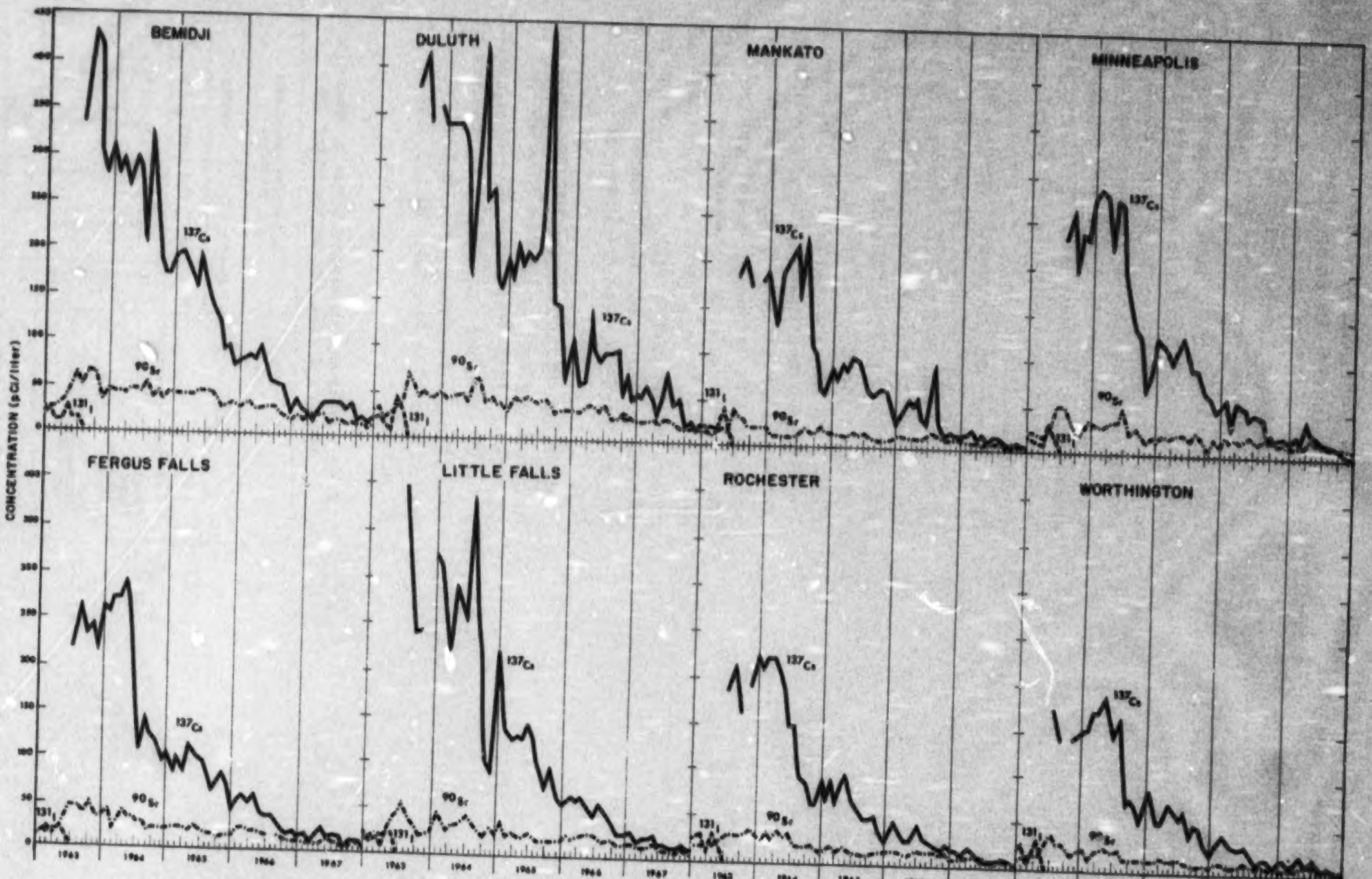

Figure 11. Radionuclide concentrations in Minnesota milk, 1963–December 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	November 1967
July–September 1967	February 1968

6. New York Milk Network
July–December 1967

Division of General Engineering and Radiological Health
Department of Health, State of New York

Pasteurized milk samples collected routinely from six cities (figure 12) are analyzed for strontium–89, strontium–90, iodine–131, cesium–137 and barium-lanthanum–140 by the New York State Department of Health. At Buffalo and Newburgh, milk samples are collected daily from processing plants and composited weekly for radiochemical analyses. At Messena and Syracuse, daily samples are composited over a 2-week period and then analyzed. In New York City, a milk sample representing the total milk supply for 1 day is analyzed weekly. The Albany sample, taken at a marketing point, is analyzed daily for iodine–131 and other gamma-ray emitting radionuclides before being composited into a weekly sample. In the event that any sample contains iodine–131 concentrations exceeding 100 pCi/liter, increased surveillance is undertaken.

Gamma-ray emitting radionuclides in milk are determined by scintillation spectrometry. Radioiodine is selectively removed in an ion exchange resin and the resin is analyzed for iodine–131 (*7, 9*). The resin effluent is analyzed and the resulting spectral data is resolved by the application of a matrix method of analysis (*8*).

The analytical procedure for determining strontium–89 and strontium–90 concentrations employs an ion-exchange system similar to that developed by Porter and Kahn (*2*).

The radiological laboratory moved its location in late May and only recently resumed normal operation. Therefore, no milk samples were analyzed from June through the end of November 1967. The radionuclide concentration of strontium–90 and cesium–137 are shown in table 6 for the month of December 1967. During this period, iodine–131 and stron-

Table 6. Radionuclide concentrations in New York pasteurized milk, December 1967

Sampling location	Radionuclide concentration (pCi/liter)	
	Strontium-90 [a]	Cesium-137 [a]
Albany	7	ND
Buffalo	9	NS
Massena	9	19
Newburgh	NS	NS
New York	NS	20
Syracuse	NS	NS

[a] Detectable limits for strontium-90 and cesium-137 are 3 pCi/liter and 20 pCi/liter, respectively.
ND, not detectable.
NS, no samples reported.

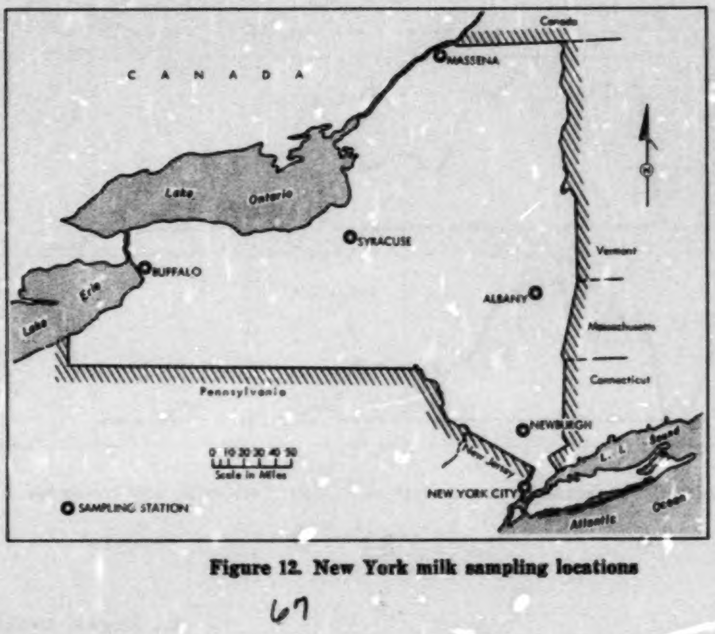

Figure 12. New York milk sampling locations

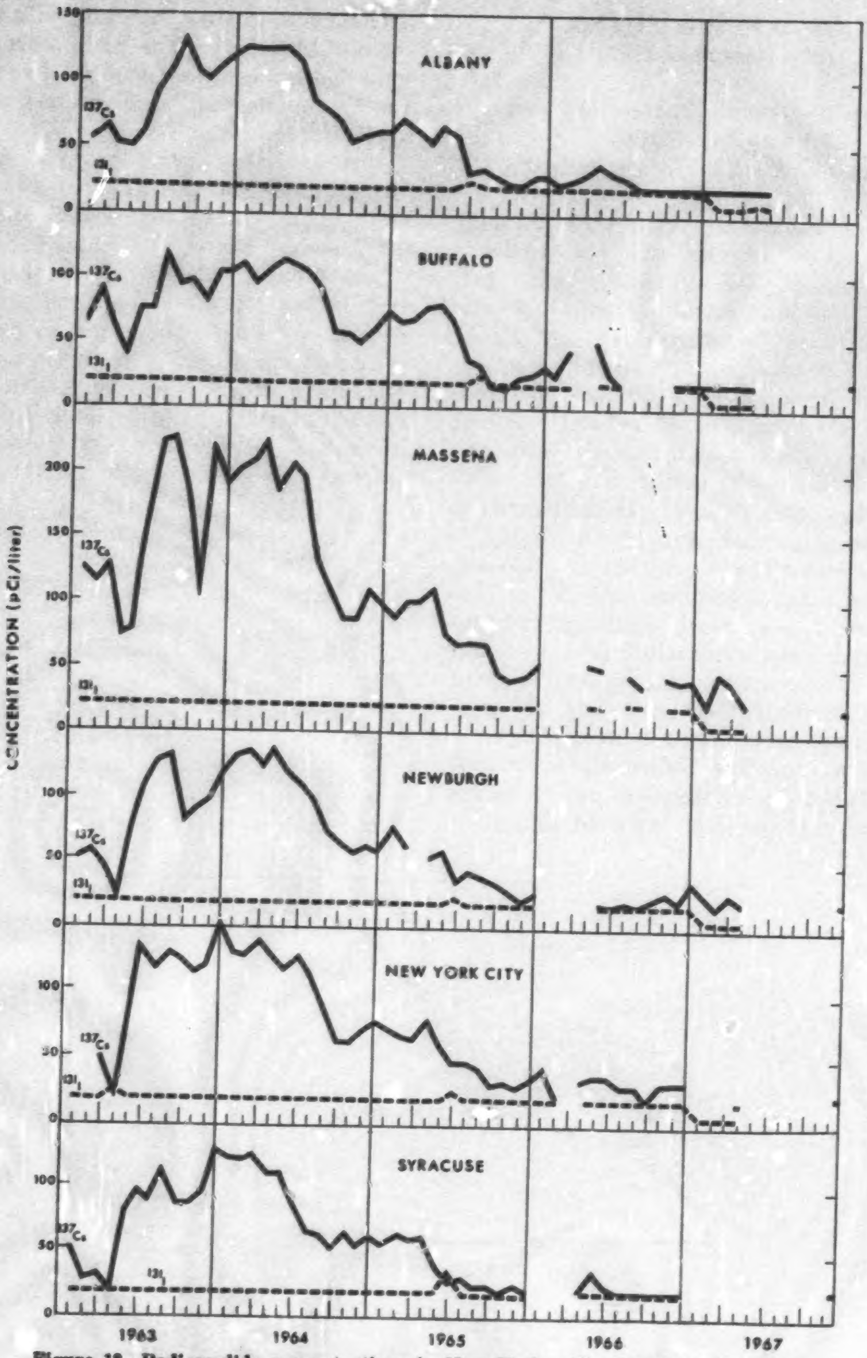

Figure 13. Radionuclide concentrations in New York milk, 1963–December 1967

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tium–89 concentrations were not reported. Cesium–137 and iodine–131 concentrations since September 1961 are presented graphically in figure 13.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–March 1967	August 1967
April–June 1967	November 1967

7. Pennsylvania Milk Network October–December 1967

Bureau of Environmental Health
Pennsylvania Department of Health

Samples of pasteurized milk are routinely collected from six major milk consumption areas throughout Pennsylvania (figure 14). Samples are collected weekly in Pittsburgh, while biweekly composite samples are collected from the other five stations. At each sampling location subsamples are collected from the major dairies supplying the area and are composited in proportion to the amount of milk processed by each dairy. This composite is then sent to the Radiation Laboratory of the Division of Occupational Health in Harrisburg where the samples are analyzed for iodine–131, potassium–40, and cesium–137 and then composited for a monthly analysis of strontium–90.

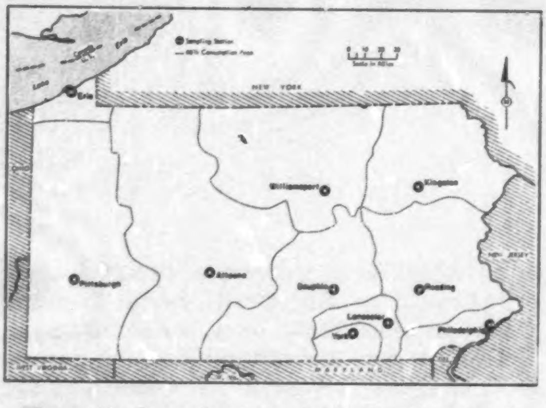

Figure 14. Pennsylvania pasteurized milk network sampling stations

Strontium–90 analysis has been carried out since April 1963.

The monthly average potassium–40, strontium–90 and cesium–137 concentrations in pasteurized milk are given in table 7. Iodine–131 concentrations for all stations for October to December 1967, were nondetectable over instrument background with three exceptions.

Table 7. Radionuclide concentrations in Pennsylvania pasteurized milk, October–December 1967

Sampling location	Radionuclide concentrations (pCi/liter)								
	Potassium-40			Strontium-90			Cesium-137		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
Altoona	1,232	1,296	1,303	14	9	8	16	13	10
Dauphin	1,241	1,211	1,330	9	10	7	18	10	16
Erie	NS	1,246	1,260	NS	12	11	NS	18	16
Philadelphia	1,280	1,287	1,474	12	10	11	16	10	13
Pittsburgh	1,254	1,216	1,292	14	12	11	17	15	13
York	NS	NS	1,249	NS	NS	7	NS	NS	12
Average	1,252	1,252	1,320	12	11	9	17	13	13

NS, no sample.

No samples were taken in October and November for York and none in Erie for the month of October. Previous reports of potassium–40 radioactivity include a calculation error. Reported values may be corrected by dividing them by a correction factor of 0.69. For comparative purposes, strontium–90, iodine–131, and cesium–137 concentrations are presented graphically in figure 15.

The chemical separation technique for strontium–90 is essentially an ion-exchange method described by Porter, *et al.* (*10*).

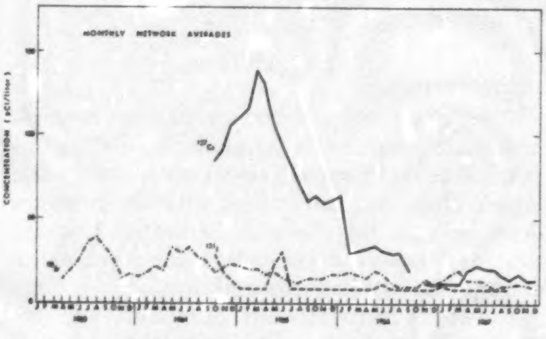

Figure 15. Radionuclide concentrations in Pennsylvania milk, 1963–September 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	November 1967
July–September 1967	February 1968

REFERENCES

(1) PORTER, C., D. CAHILL, R. SCHNEIDER, P. ROBBINS, W. PERRY and B. KAHN. Determinations of strontium-90 in milk by an ion-exchange method. Anal Chem 33:1306–1308 (September 1961).

(2) PORTER, C., and B. KAHN. Improved determinations of strontium-90 in milk by ion exchange method. Anal Chem 36:376–678 (March 1964).

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(4) PORTER, C, R. AUGUSTINE, J. MATUSEK, JR., and M. CARTER. Procedures for determination of stable elements and radionuclides in environmental samples, Publication No. 999–RH–10. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (January 1965).

(5) MICHIGAN DEPARTMENT OF HEALTH. Michigan milk network, November 1962–December 1964. Radiol Health Data 6:487–492 (September 1965).

(6) MINNESOTA DEPARTMENT OF HEALTH AND RURAL COOPERATIVE POWER ASSOCIATION. Survey of environmental radioactivity; January–June 1965, C00–615–17. Minnesota Department of Health and Rural Cooperative Power Association (August 1965).

(7) JOHNSON, R. H., and T. C. REAVEY. Evaluation of ion exchange cartridges for field sampling of iodine–131 in milk. Nature 208:750–752 (November 1965).

(8) KAHN, B., G. K. MURTHY, C. PORTER, G. R. HAGEE, G. J. KARCHES, and A. S. GOLDIN. Rapid methods for estimating fission product concentrations in milk, PHS Publication No. 999–R–2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

(9) PORTER, C. R., and M. W. CARTER. Field method for rapid collection of iodine–131 from milk. Public Health Rep 80:453–456 (May 1965).

(10) PORTER, C. D., R. SCHNEIDER, P. ROBBINS, W. PERRY, and B. KAHN. Improved determination of strontium–90 in milk by an ion-exchange method. Anal Chem 36:676–678 (March 1964).

Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Periodically, results from the United Kingdom Diet Survey, conducted by the United Kingdom Agricultural Research Council Radiobiological Laboratory, are presented for comparison with data observed in the United States. Programs most recently reported in *Radiological Health Data and Reports* and not covered in this issue are as follows.

Program	Period reported	Last presented
Institutional Diet, *PHS*	July–September 1967	April 1968
Tri-City Diet, *HASL*	January–June 1967	March 1968

1. Estimated daily intake of radionuclides in California diets, July–October 1967

Bureau of Radiological Health
California State Department of Public Health

Since January 1964, the Bureau of Radiological Health, California State Department of Public Health, has made estimates of radionuclide levels in the diets of Californians (*1*).

Recognizing that a "standard" or "typical" diet does not exist due to variations in individual tastes, an effort was made to select a diet which was reasonably representative of the food consumed in a given area. This objective was met by utilizing the "house" diet of a hospital in each of the 20 geographic areas of interest (figure 1).

Hospitals were chosen as the source of diet samples under the hypothesis that their diets are as "reasonably representative" as any other. General hospitals exist in each of the 20 selected geographic areas and operate with trained dietitians. There is good reason to believe that hospitals utilize foods which are marketed in their respective communities. Also, working relations for entry into hospitals existed through the State Bureau of Nutrition and Hospitals.

Sampling procedure

In general, the sampling procedure is the same at each hospital. Samples are collected every 2 months at each facility. Each sample represents the edible portion of a regular meal

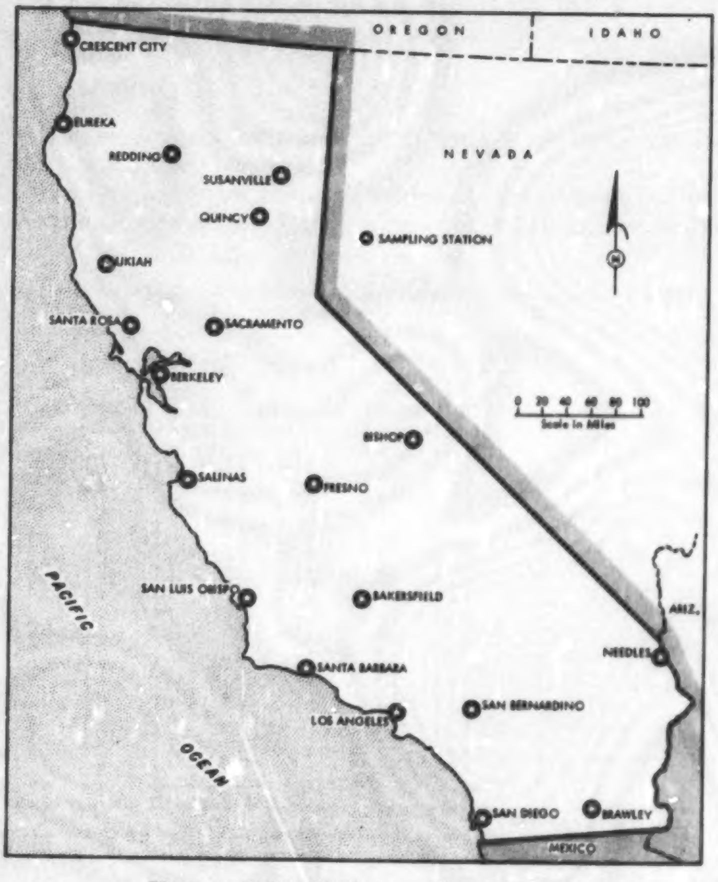
OREGON
IDAHO
NEVADA
CRESCENT CITY
EUREKA
REDDING
SUSANVILLE
QUINCY
SAMPLING STATION
UKIAH
SANTA ROSA
SACRAMENTO
BERKELEY
0 20 40 60 80 100
Scale in Miles
BISHOP
SALINAS
FRESNO
PACIFIC
SAN LUIS OBISPO
BAKERSFIELD
ARIZ.
NEEDLES
SANTA BARBARA
LOS ANGELES
SAN BERNARDINO
OCEAN
SAN DIEGO
BRAWLEY
MEXICO

Figure 1. California diet sampling stations

Table 1. Estimated daily intake of radionuclides in California diets,[a] July–August 1967

City	Consumption (kg/capita • day) [b]	Intake (pCi/capita • day)						Intake (g/capita • day)			
		^{89}Sr [c]	^{90}Sr	^{226}Ra	^{137}Cs	^{140}Ba-La	^{95}Zr	K [d]	Na	Ca	Stable Sr
Bakersfield	2.1	ND	5	1.2	12	31	0	2.9	4.2	0.9	0.003
Berkeley	1.5	1	3	0.4	7	0	[c] 2	1.4	2.8	.5	.002
Bishop	2.1	ND	6	1.3	6	0	0	3.3	3.2	.3	NA
Brawley	2.1	1	5	1.5	19	[c] 16	0	3.2	2.9	.6	NA
Crescent City	2.2	ND	15	2.0	20	0	0	2.9	3.2	.8	.003
Eureka	2.1	1	6	.7	13	29	0	2.4	3.3	1.0	.003
Fresno	2.1	ND	7	1.0	14	36	0	2.1	2.1	.7	.002
Los Angeles	2.5	1	8	1.3	20	41	0	3.0	3.5	1.1	.003
Needles	2.2	0	6	1.2	10	17	0	2.7	3.6	.9	.003
Quincy	1.8	1	4	1.0	13	31	0	2.1	2.5	.7	.002
Redding	1.9	1	[c] 5	.9	14	34	0	1.9	2.5	.7	.003
Sacramento	2.7	1	7	2.8	5	0	0	3.0	5.8	1.3	.004
Salinas	2.3	1	7	1.5	16	0	0	2.8	5.2	.7	.002
San Bernardino	1.7	2	5	1.4	10	19	0	2.3	3.3	.7	.003
San Diego	2.4	3	5	1.1	11	0	0	3.2	2.9	.9	.004
San Luis Obispo	2.1	0	7	1.6	20	50	0	2.7	4.1	1.0	.003
Santa Barbara	1.8	ND	7	1.2	10	0	0	2.3	3.1	1.2	.005
Santa Rosa	2.0	0	4	.8	10	0	0	2.0	2.9	1.1	.004
Susanville	2.0	1	4	.8	12	0	[c] 3	3.3	3.3	.7	.004
Ukiah	NS										

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[a] Based on analyses of Hospital Standard Diets located in listed cities. Intake for manganese-54 and cerium-141, -144, for all stations, 0.

[b] Kilograms of food per person per day in this diet.

[c] When the counting rate of the sample is not equal to at least twice the 0.95 error, the value reported is the best available estimate, but is not statistically significant.

[d] Natural potassium contains 0.0119 percent of radioactive potassium-40.

ND, non detectable.
NA, no analysis.
NS, no sample.

(the standard diet) for a full 7-day week (21 consecutive meals.)

After each sample is collected, it is suitably preserved and shipped to the Sanitation and Radiation Laboratory of the State Department of Public Health. Accompanying each sample is a record prepared by the dietitians indicating the types and quantities of food included.

Table 2. Estimated daily intake of radionuclides in California diets,[a] September–October 1967

City	Consumption (kg/capita • day) [b]	Intake (pCi/capita • day)						Intake [e] (g/capita • day)		
		^{89}Sr [c]	^{90}Sr	^{226}Ra	^{137}Cs	^{140}Ba-La	^{54}Mn	K [d]	Na	Ca
Bakersfield	2.3	ND	7	1.8	15	32	0	3.7	3.8	1.2
Berkeley	1.8	ND	5	1.4	10	0	0	2.0	2.1	0.4
Bishop	2.9	ND	7	1.5	23	0	0	4.5	5.1	1.2
Brawley	2.0	ND	5	0.6	12	0	0	3.0	4.5	.8
Crescent City	2.1	1	14	1.3	22	0	0	3.3	3.9	1.0
Eureka	1.9	ND	5	1.2	9	0	0	2.6	3.6	.6
Fresno	2.3	3	6	1.2	17	0	0	2.6	4.4	1.0
Los Angeles	2.2	3	4	1.0	17	0	0	3.3	4.2	.9
Needles	2.4	ND	4	1.0	12	0	0	2.9	3.8	.9
Quincy	2.1	ND	4	1.4	23	[c] 16	0	3.0	2.9	.8
Redding	2.0	ND	4	.5	13	0	0	3.0	3.5	1.0
Sacramento	2.7	ND	5	.8	17	0	0	3.4	5.5	1.2
Salinas	2.4	ND	4	1.6	14	0	0	3.8	6.0	.8
San Bernardino	1.8	ND	5	1.1	9	0	0	3.0	3.4	.9
San Diego	2.2	ND	4	2.6	14	0	0	3.3	2.6	.8
San Luis Obispo	1.8	ND	3	1.4	5	0	5	2.7	3.6	.7
Santa Barbara	2.0	ND	5	[c] .2	16	0	0	3.1	3.5	1.0
Santa Rosa	1.7	ND	4	.7	18	0	0	2.0	2.7	.7
Susanville	2.0	ND	5	3.1	14	0	0	3.0	3.9	.9
Ukiah	2.1	ND	3	1.1	11	0	0	2.6	3.4	.9

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[a] Based on analyses of Hospital Standard Diets located in listed cities. Zirconium-95 and cerium-141, -144 intakes for all stations are 0.

[b] Kilograms of food per person per day in this diet.

[c] When the counting rate of the sample is not equal to at least twice the 0.95 error, the value reported is the best available estimate, but is not statistically significant.

[d] Natural potassium contains 0.0119 percent of radioactive potassium-40.

[e] Discontinued periodic analysis for stable strontium, annual composite only.

ND, nondetectable.

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Analytical procedures

After weighing at the laboratory, each sample is homogenized and analyzed for gamma-ray emitters, then dried and ashed prior to analysis for strontium-89, strontium-90, radium-226, and stable calcium, strontium, and sodium.

Data and discussion

The resultant estimates of daily intake of radionuclides in the California diets are given in table 1 (July-August 1967), and table 2 (September-October 1967).

It should be noted that levels of radioactivity were observed to be far below those levels for which consideration should be given to protective health action. A summary of strontium-90 and cesium-137 intake trends in California diets from January 1964 through October 1967 is given in figures 2 and 3.

REFERENCE

(*1*) STATE OF CALIFORNIA DEPARTMENT OF PUBLIC HEALTH, BUREAU OF RADIOLOGICAL HEALTH. Radiol Health News 4:4 (October 1965). 2151 Berkeley Way, Berkeley 4, Calif.

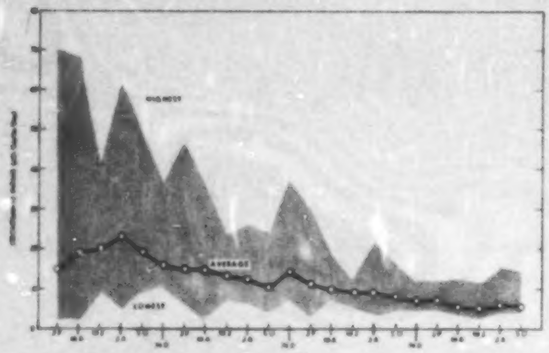

Figure 2. Average and ranges of daily strontium-90 intake in California diets, 1964-October 1967

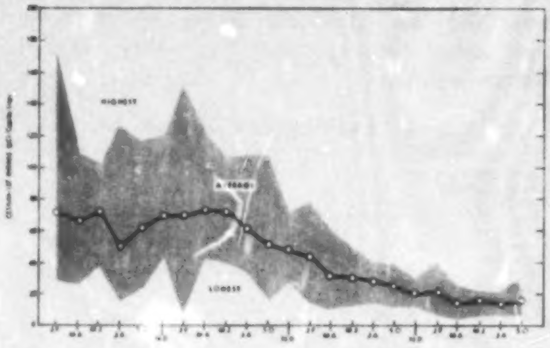

Figure 3. Averages and ranges of daily cesium-137 in California diets, 1964-October 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
September 1966-February 1967	October 1967
March-June 1967	February 1968

2. Estimated daily intake of radionuclides in Connecticut standard diet July–December 1967

Connecticut State Department of Health

The Connecticut State Department of Health has been analyzing a standard diet on a monthly basis since March 1963. Analysis are made for strontium–89, strontium–90, and gamma-ray emitters.

The standard diet was selected to represent the food intake of an 18-year-old boy for 1 day (table 3). The total weight of the complete blended diet, averaging 3 kilograms, included milk and dairy products. When raw fruit or vegetables were sampled, they were washed before blending.

Table 3. Foods included in standard diet

Bread, white—6 slices
Butter ½ stick
Carrots, scraped—½ cup
Celery, washed and trimmed—3 stalks
Cookies—4
Cottage cheese—2/3 cup
Cupcakes—2
Egg—1
Green beans, washed—½ cup
Ham—85 grams
Hamburger—227 grams
Ice cream—½ pint
Lettuce, washed—4-5 leaves
Milk—3 cups
Oatmeal—uncooked—43 grams
Orange—1
Peanut butter—2½ tablespoons
Pears, canned—2 halves with juice
Potatoes, washed, not peeled—2
Sugar—5 tablespoons
Tomato juice—113 grams
Tuna fish, drained—43 grams

Cesium–137 concentrations were determined by gamma-ray spectrometry (*1*). Strontium–89 and strontium–90 concentrations were determined by chemical separation techniques (*1*).

Table 4 presents the analytical results for the Connecticut standard diet from July through December 1967. Results representative of the total daily intake for the radionuclides observed are presented in table 5.

In order to evaluate general trends, the strontium–90 and cesium–137 daily intakes are plotted as a function of time in figure 4 and 5.

Table 4. Radionuclide concentrations in Connecticut standard diet,[a] July–December 1967

Month (1967)	Potassium (g/kg)	Strontium-90 (pCi/kg)	Cesium-137 (pCi/kg)
July	2.2	9	30
August	NA	NA	NA
September	2.4	13	20
October	2.1	10	20
November	NA	NA	NA
December	2.0	8	10

[a] All strontium-89 values were <3 for this period.
NA, no analysis.

Table 5. Daily radionuclide intakes in Connecticut standard diet,[a] July–December 1967

Month (1967)	Potassium (g/day)	Strontium-90 (pCi/day)	Cesium-137 (pCi/day)
July	7.1	30	80
August	NA	NA	NA
September	7.3	30	60
October	6.8	33	70
November	NA	NA	NA
December	5.0	26	40

[a] All strontium-89 values were <3 for this period.
NA, no analysis.

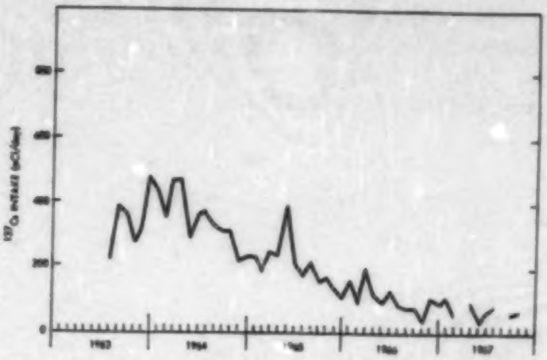

Figure 4. Cesium–137 intake in Connecticut standard diet, 1963–December 1967

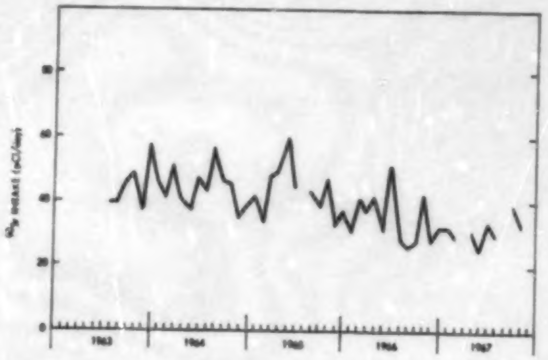

Figure 5. Strontium–90 intake in Connecticut standard diet, 1963–December 1967

REFERENCE

(*1*) CONNECTICUT STATE DEPARTMENT OF HEALTH. Estimated daily intake of radionuclides in Connecticut standard diet, March 1963–December 1964. Radiol Health Data 6:381–382 (July 1965).

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1966	May 1967
January–June 1967	November 1967

SECTION II. WATER

The Public Health Service, the Federal Water Pollution Control Administration and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*), set the limits for approval of a drinking water supply containing radium-226 and strontium-90 as 3 pCi/liter and 10 pCi/liter, respectively. Limits may be set higher if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities, recently reported in *Radiological Health Data and Reports* are listed below.

Water sampling program	Period reported	Last presented
California	July–December 1966	February 1968
Coast Guard	January–December 1966	November 1967
Minnesota Municipal	January–June 1967	January 1968
New York Surface	January–May 1967	January 1968
Radiostrontium in Tap Water, *HASL*	July–December 1966	November 1967
Washington Surface	July 1965–June 1966	August 1967

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[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90 respectively.

REFERENCES

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(*2*) FEDERAL RADIATION COUNCIL. Radiation Protection Guidance for Federal Agencies. Memorandum for the President, September 1961. Reprint from the Federal Register of September 26, 1961.

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

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Gross Radioactivity in Surface Waters of the United States, November 1967

*Division of Pollution Surveillance, Federal Water Pollution Control Administration
Department of Interior*

The monitoring of levels of radioactivity in surface waters of the United States was begun in 1957 as part of the Federal Water Pollution Control Administration's Water Pollution Surveillance System. Table 1 presents the current preliminary results of the alpha and beta radioanalyses. The radioactivity associated with dissolved solids provides a rough indication of the levels which would occur in treated water, since nearly all suspended matter is removed by treatment processes. Strontium-90 results are reported semiannually. The stations on each river are arranged in the table according to their distance from the headwaters. Figure 1 indicates the average total beta radioactivity in suspended-plus dissolved solids in raw water collected at each station. A description of the sampling and analytical procedures was published in the August 1967 issue of *Radiological Health Data and Reports.*

Complete data and exact sampling locations for 1958 through 1963 are published in annual compilations (*1–6*). Data for subsequent years are available on request.

Special note is taken when the alpha radioactivity is 15 pCi/liter or greater or when the beta radioactivity is 150 pCi/liter or greater. These arbitrary levels provide a basis for the selection of certain data for comment. They reflect no public health significance as the Public Health Service drinking water standards have already provided the basis for this assessment. Changes from or toward these arbitrary levels are also noted in terms of changes in radioactivity per unit weight of solids. A discussion of gross radioactivity per gram of

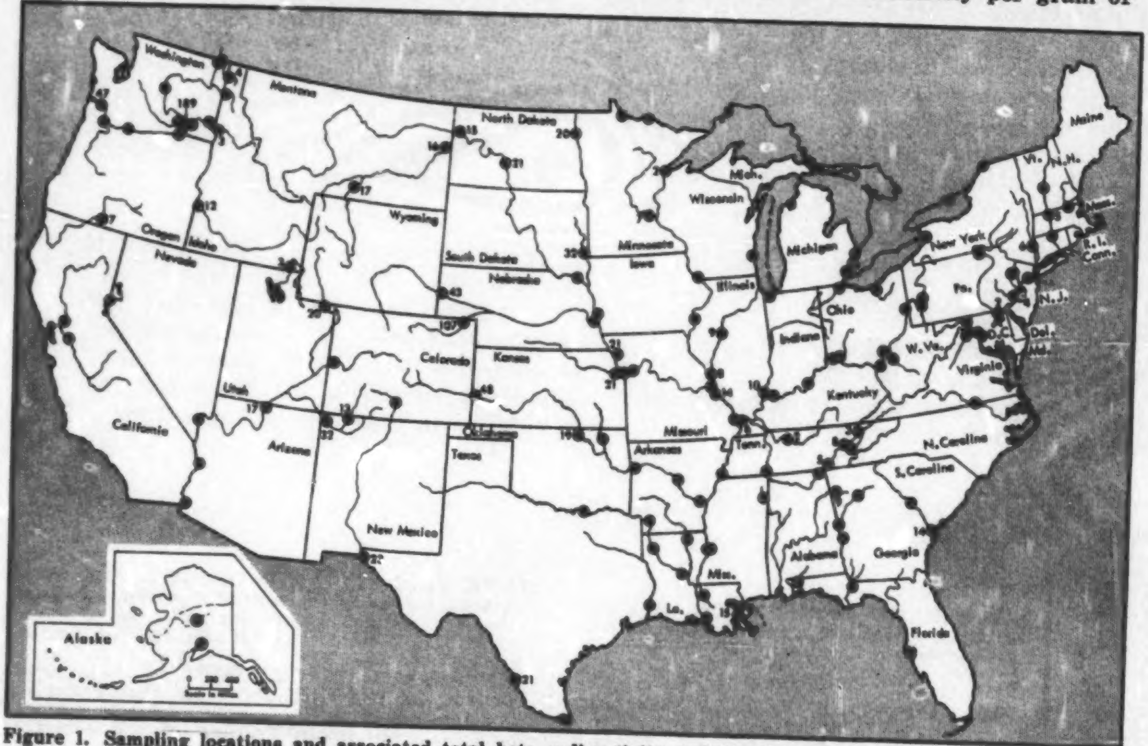
Washington
Montana
North Dakota
Minnesota
Mich.
Wisconsin
Maine
Vt.
N.H.
Mass.
R.I.
Conn.
New York
Michigan
Oregon
Idaho
Wyoming
South Dakota
Nevada
Nebraska
Iowa
Illinois
Ohio
Pa.
N.J.
Del.
Md.
D.C.
Indiana
W. Va.
Virginia
Utah
Colorado
Kansas
Kentucky
California
Missouri
Arizona
Oklahoma
Tenn.
N. Carolina
Arkansas
S. Carolina
Texas
New Mexico
Alabama
Georgia
Miss.
La.
Florida
Alaska

Figure 1. Sampling locations and associated total beta radioactivity (pCi/liter) in surface waters, November 1967

solids for all stations of the Water Pollution Surveillance System for 1961 through 1965 has been presented (7). Comments are made only on monthly average values. Occasional high values from single weekly samples may be absorbed into a relatively low average. When these values are significantly high, comment will be made.

During October and November 1967, the following stations showed values in excess of 15 pCi/liter on alpha radioactivity for dissolved solids:

Arkansas River; Coolidge, Kans.
North Platte River; Henry, Nebr.
South Platte River; Julesburg, Colo.

During November 1967, radioactivity at Loma, Colo., on the Colorado River decreased to less than 15 pCi/liter for suspended solids.

Pasco, Wash., on the Columbia River showed a beta radioactivity on dissolved solids of slightly over 150 pCi/liter.

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(1) PUBLIC HEALTH SERVICE, DIVISION OF WATER SUPPLY AND POLLUTION CONTROL. National water quality network annual compilation of data, PHS Publication No. 663, 1958 Edition. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(2) *Ibid.*, 1959 Edition.

(3) *Ibid.*, 1960 Edition.

(4) *Ibid.*, 1961 Edition.

(5) *Ibid.*, 1962 Edition.

(6) PUBLIC HEALTH SERVICE, DIVISION OF WATER SUPPLY AND POLLUTION CONTROL. Water pollution surveillance system, annual compilation of data, PHS Publication No. 663 (Revised), 1963 Edition. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(7) JULIAN, E. C. Gross radioactivity of the solids in selected surface waters of the United States, 1961–1965. Radiol Health Data Rep 9:1–12 (January 1968).

Table 1. Radioactivity in raw surface waters, November 1967

Station	Average alpha radioactivity (pCi/liter)			Average beta radioactivity (pCi/liter)		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River:						
Cedar Hill, N. Mex.	0	2	2	2	11	13
Arkansas River:						
Coolidge, Kans.	<1	34	34	5	43	48
Ponca City, Okla.	0	4	4	1	18	19
Bear River:						
Preston, Idaho	0	2	2	0	3	3
Big Horn River:						
Hardin, Mont.	0	8	8	1	16	17
Big Sioux River:						
Sioux Falls, S. Dak.	1	5	6	5	27	32
Clearwater River:						
Lewiston, Idaho	0	0	0	1	2	3
Clinch River:						
Clinton, Tenn.	0	1	1	0	3	3
Kingston, Tenn [a]	0	0	0	0	8	8
Colorado River:						
Loma, Colo.	3	6	9	9	16	25
Page, Ariz.	0	5	5	1	16	17
Parker Dam, Calif-Ariz.	0	7	7	0	17	17
Columbia River:						
Pasco, Wash [a]	0	<1	<1	19	170	189
Clatskanie, Ore.	0	<1	<1	11	36	47
Connecticut River:						
Enfield Dam, Conn.	0	0	0	1	4	5
Coosa River:						
Rome, Ga.	1	<1	1	6	3	9
Cumberland River:						
Cheatham Lock, Tenn.	0	0	0	0	2	2
Delaware River:						
Philadelphia, Pa.	0	0	0	1	3	4
Great Lakes:						
Duluth, Minn.	0	0	0	0	2	2
Green River:						
Dutch John, Utah	0	3	3	4	16	20
Hudson River:						
Poughkeepsie, N. Y.	0	0	0	1	5	6
Illinois River:						
Peoria, Ill.	1	2	3	2	7	9
Grafton, Ill.	0	1	1	1	7	8
Kansas River:						
DeSoto, Kans.	1	3	4	3	18	21
Klamath River:						
Keno, Ore.	0	0	0	1	6	7
Mississippi River:						
St. Paul, Minn.	0	1	1	0	7	7
E. St. Louis, Ill.	3	1	4	7	7	14
New Orleans, La.	1	1	2	6	9	15
Missouri River:						
Williston, N. Dak.	0	5	5	3	12	15
Bismarck, N. Dak.	<1	4	4	3	18	21
St. Joseph, Mo.	1	4	5	5	16	21
North Platte River:						
Henry, Nebr.	1	27	28	5	38	43
Ohio River:						
Cairo, Ill.	0	0	0	1	5	6
Pend Oreille River:						
Albeni Falls Dam, Idaho	0	1	1	1	3	4
Platte River:						
Plattsmouth, Nebr.	4	6	10	15	19	34
Potomac River:						
Washington, D. C.	0	0	0	1	3	4
Red River, North:						
Grand Forks, N. Dak.	0	1	1	1	19	20
Rio Grande:						
El Paso, Tex.	1	1	2	3	20	23
Laredo, Tex.	2	5	7	8	13	21
San Juan River:						
Shiprock, N. Mex.	6	3	9	21	11	32
Savannah River:						
Port Wentworth, Ga [a]	<1	0	<1	5	9	14
Snake River:						
Payette, Idaho	0	4	4	1	11	12
South Platte River:						
Julesburg, Colo.	12	33	45	49	58	107
Susquehanna River:						
Conowingo, Md.	0	0	0	0	2	2
Tennessee River:						
Chattanooga, Tenn.	0	0	0	1	4	5
Wabash River:						
New Harmony, Ind.	1	1	2	3	7	10
Yellowstone River:						
Sidney, Mont.	0	2	2	1	15	16
Maximum	12	34	45	49	170	189
Minimum	0	0	0	0	2	2

[a] Gross beta radioactivity at this station may not be directly comparable to gross beta radioactivity at other stations because of the possible contribution of radionuclides from an upstream nuclear facility in addition to the contribution from fallout and naturally occurring radionuclides.

Radioactivity in Surface Waters of the Colorado River Basin, 1965–1966

Colorado River Basin Water Quality Control Project
Federal Water Pollution Control Administration
Department of the Interior

The Radium Monitoring Network is a surface water surveillance system currently consisting of 21 sampling stations located throughout the Colorado River basin. During initial stages of the surveillance program, the system consisted of 27 sampling stations (figure 1). The purpose of this network is to provide a continuous assay of basin river water radioactivity resulting primarily from uranium mining and milling industry waste discharges. Recently, the types of sample analyses were expanded from radium-226 and uranium to include gross alpha radioactivity, gross beta radioactivity, thorium alpha radioactivity, lead-210 and strontium-90, to provide a more comprehensive picture of contributions of radiological contaminants to surface waters of the Colorado River Basin by the uranium industry and by fallout from nuclear testing. The network was established following a 1957 conference on uranium milling wastes, attended by representatives of the States of Arizona, Colorado, New Mexico, and Utah, and the U.S. Public Health Service. A summary of data collected through 1964 was published in November 1965 (*1*).

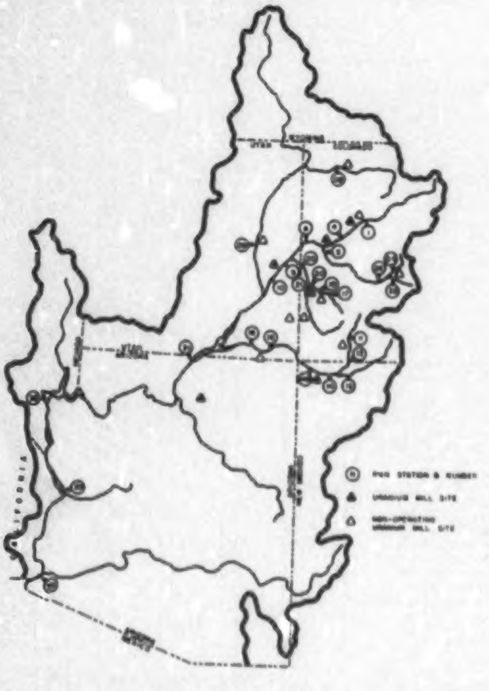

Figure 1. Colorado River basin Radium Monitoring Network

Sampling procedures

Depending on individual station parameters, Radium Monitoring Network (RMN) samples are collected as either automatic or grab samples. Grab samples are collected once or three times per week and automatic samplers collect 21 milliliter portions every hour. The samples are sent as collected to the Colorado River Basin Water Quality Control Project Laboratory where they are composited, filtered, and analyzed for the desired radionuclides.

Radium-226 with lowest recommended maximum permissible concentration in water of all radionuclides, has been the radioactive contaminant of greatest concern in uranium discharges. Consequently, initial and primary emphasis was placed on the analysis for radium only. In October 1963, uranium determinations were added. Beginning in July 1963, samples from selected stations were combined into quarterly composites for gamma-ray spectroscopy and analyzed for gross alpha, gross beta, strontium-90, thorium alpha, and lead-210 radioactivities. Some determinations for polonium-210 were also performed.

Analytical methods

Water samples are composited and filtered through 0.45 micron-membrane filters as soon as possible after the samples for the compositing period are received. After filtration, samples are acidified with a 2 percent by volume 12N hydrochloric acid and radiochemical determinations are then performed on the filtered water.

Radium–226 is determined by an emanation method (*2*). Lead–210 is determined by an iodine-dithiozone extraction method (*3*). Uranium is determined by a fluorometric method, using a sodium carbonate-potassium carbonate-sodium fluoride flux (*4*). Gross alpha and beta radioactivity determinations are made on dried dissolved solids from the waters, using appropriate correction factors for self-absorption. Strontium–90 is isolated by coprecipitation with calcium and magnesium carbonate. It is absorbed in an ion exchange column and the yttrium–90 which grows is eluted and measured. Gross gamma-ray determinations are performed using a sodium iodide crystal as a detector and a scaler as the recording device.

Alpha-particle emitting thorium isotopes are determined by coprecipitation with ferric hydroxide and lanthanum fluoride followed by extraction with thenoyltrifluoroacetone, mounting, and alpha-particle counting.

Results

A summary of radium–226 and uranium determinations on RMN samples for 1965–1966 are given in tables 1 and 2. During the 2-year period, radium–226 concentrations in the Animas River remained low because of the shutdown of the Durango, Colo., uranium mill in 1963. Only one sample taken from the Colorado River contained radium–226 in excess of 1.0 picogram per liter which may indicate pollution from the mill at Moab, Utah. Radium concentrations in Lakes Mead and Havasu were nearly identical during the 2-year period.

Elevated radium and uranium concentrations in the Dolores River at Gateway, Colo., are attributed primarily to waste discharges from the mill at Uravan, Colo. Average radium and uranium concentrations for the San Miguel River below Uravan, Colo., elevated during the last half of 1966, are attributed to waste discharges from the mill at Uravan. Only the stations at Gateway and below Uravan, Colo., had annual radium averages above 1.0 picogram per liter.

Composited samples were analyzed for gross alpha radioactivity, gross beta radioactivity, strontium–90, thorium (alpha-particle emitting), lead–210, and polonium–210. Most of the concentrations that were given for thorium, lead–210, and polonium–210 were near "background" levels. The dissolved thorium concentrations of 1.0 to 1.5 picocuries per liter detected at Silt, and below Uravan, Colo., were noticeably higher than concentrations observed at other stations. The strontium–90 concentrations varied with the quarter and station, but are well below the accepted standards.

The dissolved alpha radioactivity below Uravan, Colo., on the San Miguel River and above and below Moab, Utah, on the Colorado River were noticeably higher than at other stations. The alpha radioactivities below Moab were somewhat higher than those above Moab, Utah, indicating some pollution between the two locations. The dissolved beta radioactivity was also higher at the same three stations. Equally high beta radioactivity was observed during the third quarter of 1966 in samples from the San Juan River above and below Mexican Hat, Utah. Since no increase was observed between those two stations, it is likely that the high beta radioactivity was not associated with pollution from former uranium mill operations at Mexican Hat.

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(*2*) RUSHING, D. E., W. J. GARCIA, and D. A. CLARK. The analysis of effluents of environmental samples from uranium mills and of biological samples for radium, polonium, and uranium. Rad Health Safety Mining Milling Nuclear Materials 11:187–230, International Atomic Energy Agency, Vienna, Austria (1964).

(*3*) TALVITIE, N. A. and W. J. GARCIA. Radiochemical determinations of lead–210 after solvent extraction as iodide and dithizonate. Anal Chem 37:854 (1965).

(*4*) GRINALDI, F. S., I. MAY, M. H. FLETCHER, and J. PITCOMB. Collected papers on methods of analysis for uranium and thorium, USGS Bulletin 1006. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (1954).

Table 1. Radium-226 in surface waters of the Colorado River basin averages
January 1965–December 1966
(concentrations pg/liter)

Sampling station number and location	1965												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly average
Animas River:													
#11 above Durango, Colo.	0.04	0.04	0.05	0.06	0.04	0.08	0.01	0.03	0.05	0.05	0.04	0.04	0.04
#12 Colo.-N. Mex. State line	.09	.09	.08	.08	.14	.08	.05	.09	.09	.06	.09	.08	.08
Colorado River:													
#1 at Silt, Colo.	.33	.30	.25	.14	.08	.09	.06	.13	.11	.15	.18	.18	.16
#4 at De Beque, Colo.	.26	.26	.24	.16	.09	.13	.06	.14	.15	.13	.20	.19	.17
#6 at Fruita, Colo.	.23	.21	.23	.15	.09	.11	.09	.13	.13	.14	.12	.40	.17
#9 above Moab, Utah	.19	.26	.21	.20	.18	.13	.16	.14	.20	.14	.20	.30	.19
#10 below Moab, Utah	.30	.29	.33	.30	.33	.19	.16	.22	.23	.16	.34	.42	.27
#31 at Page, Ariz.	.05	.21	.21	.22	.25	.22	.12	.16	.20	.10	.13	.16	.17
#32 Lake Mead, Nev.	.35	.31	.39	.40	.36	.31	.39	.45	.42	.51	.54	.52	.41
#33 Lake Havasu, Calif.	.33	.33	.30	.34	.38	.36	.38	.31	.41	.39	.39	.40	.36
#30 at Yuma, Ariz.	.16	.13	.24	.15	.08	.18	.23	.25	.19	.09	.10	.15	.16
Dolores River:													
#21 at Bedrock, Colo.	.38	.40	.44	.14	.16	.09	.16	.26	.59	.26	.25	.21	.28
#26 at Gateway, Colo.	.84	1.10	.84	.48	.38	.38	.86	.48	.66	.54	.73	.76	.67
Green River:													
#28 below Maybell, Colo.	.08	.06	.09	.06	.03	(a)							.06
Gunnison River:													
#24 above Gunnison, Colo.	.03	.05	.05	.01	.05	.04	(a)						.04
#25 below Gunnison, Colo.	.05	.03	.03	.03	.03	.03	(a)						.03
#5 at Grand Junction, Colo.	.11	.09	.06	.09	.06	.08	.09	.04	.04	.03	.04	.09	.07
San Juan River:													
#14 below Farmington, N. Mex.	.11	.03	.05	.08	.08	.08	.06	.04	.03	.05	.04	.03	.06
#14S below Shiprock, N. Mex.	.07	.08	.08	.06	.10	.06	.06	.05	.06	.05	.05	.05	.06
#15 above Mexican Hat, Utah	.04	.06	.06	.05	NS	NS	NS	NS	NS	.08	.08	.09	.07
#16 below Mexican Hat, Utah	.05	.06	.08	.06	NS	NS	NS	NS	NS	.06	.06	.09	.07
San Miguel River:													
#17 above Naturita, Colo.	.14	.04	.04	.04	.04	.08	.04	.05	.03	.03	.04	.04	.05
#18 above Uravan, Colo.	.13	.10	.13	.41	.16	.09	.08	.15	.10	.08	.09	.35	.16
#20 below Uravan, Colo.	.89	.14	.30	.61	.19	.15	.16	.16	.57	.40	.48	.70	.48

Table 2. Uranium in surface waters of the Colorado River basin averages
January 1965–December 1966
(concentrations μg/liter)

Sampling station number and location	1965												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly average
Animas River:													
#11 above Durango, Colo.	1.2	1.0	1.4	1.4	0.9	1.5	2.0	1.4	2.2	2.1	0.6	1.8	1.5
#12 Colo.-N. Mex. State line	2.7	2.7	3.2	2.4	1.7	2.3	1.8	2.2	2.8	1.2	2.2	2.3	2.3
Colorado River:													
#1 at Silt, Colo.	3.7	3.6	3.5	3.2	1.9	2.2	2.8	1.5	3.9	4.2	3.6	3.0	3.1
#4 at De Beque, Colo.	5.3	4.9	3.5	2.9	1.9	2.2	3.0	2.3	4.5	4.0	2.3	2.5	3.3
#6 at Fruita, Colo.	11.0	9.1	9.4	4.6	2.0	3.3	3.0	6.4	9.3	10.0	7.8	8.1	7.0
#9 above Moab, Utah	11.0	11.0	11.0	7.2	2.6	3.6	3.6	6.4	9.7	11.0	8.9	8.0	7.8
#10 below Moab, Utah	14.0	14.0	13.0	8.1	3.0	2.4	4.7	7.2	12.0	11.0	14.0	9.1	9.5
#31 at Page, Ariz.	9.4	7.2	7.6	6.8	7.5	7.0	3.6	3.1	2.8	3.5	3.2	4.1	5.5
#32 Lake Mead, Nev.	8.5	9.5	10.0	9.1	8.4	9.7	9.9	9.1	11.0	9.0	8.5	8.3	9.2
#33 Lake Havasu, Calif.	9.2	8.4	10.0	9.1	8.4	8.0	11.0	5.7	6.9	6.7	8.4	7.8	8.3
#30 at Yuma, Ariz.	7.8	8.4	9.8	8.2	6.5	8.6	10.0	10.0	9.5	11.0	6.3	6.4	8.5
Dolores River:													
#21 at Bedrock, Colo.	11.0	11.0	11.0	2.6	0.6	1.5	2.5	5.3	8.3	5.8	7.0	4.2	5.9
#26 at Gateway, Colo.	32.0	20.0	22.0	10.0	2.9	4.4	6.5	9.5	12.0	14.0	12.0	13.0	13.9
Green River:													
#28 below Maybell, Colo.	2.3	3.2	2.9	3.5	1.8	(a)							2.7
Gunnison River:													
#24 above Gunnison, Colo.	1.7	1.4	1.4	0.9	0.3	2.5	(a)						1.4
#25 below Gunnison, Colo.	3.6	3.7	3.2	2.2	1.6	3.4	(a)						2.8
#5 at Grand Junction, Colo.	13	11	9.4	4.0	2.6	4.6	3.6	6.9	9.7	12.0	15.0	12.0	8.6
San Juan River:													
#14 below Farmington, N. Mex.	2.0	2.0	2.6	2.3	1.7	1.3	1.5	1.5	2.4	2.5	0.4	0.8	1.8
#14S below Shiprock, N. Mex.	6.1	2.9	6.1	4.0	2.9	2.4	2.7	3.2	5.4	5.3	1.7	2.6	3.8
#15 above Mexican Hat, Utah	4.8	3.7	5.8	4.0	NS	NS	NS	NS	NS	2.8	2.1	2.2	3.6
#16 below Mexican Hat, Utah	5.3	4.6	10.5	3.6	NS	NS	NS	NS	NS	3.6	2.2	2.5	4.6
San Miguel River:													
#17 above Naturita, Colo.	1.7	1.4	1.4	1.0	1.2	1.8	1.7	1.5	3.3	5.0	2.7	2.9	2.1
#18 above Uravan, Colo.	4.9	4.9	5.0	2.6	1.3	2.0	2.8	3.6	5.0	5.6	4.4	8.3	4.2
#20 below Uravan, Colo.	56.8	37.0	18.8	15.3	3.0	4.4	3.8	6.1	16.5	15.6	11.8	20.4	17.5

Table 1. Radium-226 in surface waters of the Colorado River basin averages January 1965–December 1966—Continued (concentrations pg/liter)

Sampling station number and location	1966												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly average
Animas River:													
#11 above Durango, Colo.	0.03	0.04	0.04	0.03	0.08	0.05	0.05	0.08	0.06	0.06	0.05	0.05	0.05
#12 Colo.-N. Mex. State line	.05	.06	.05	.05	.06	.06	.11	.19	.14	.10	.06	.06	.09
Colorado River:													
#1 at Silt, Colo.	.21	.18	[illegible]	.14	.08	.11	.18	.24	.22	.25	.28	.30	.20
#4 at De Beque, Colo.	.30	.20	.14	.14	.09	.12	.16	.20	.22	.21	.22	.23	.18
#6 at Fruita, Colo.	.16	.12	.15	.11	.12	.15	.20	.19	.16	.16	.18	.16	.16
#9 above Moab, Utah	.37	.25	.25	.19	.19	.22	.34	.28	.24	.26	.21	.21	.26
#10 below Moab, Utah	.28	.32	.22	.22	.18	.20	.30	.65	.28	.28	.28	1.50	.38
#31 at Page, Ariz.	.15	.14	.19	.19	.18	.12	.12	NS	.14	.13	NS	NS	.15
#32 Lake Mead, Nev.	.60	.40	.42	.41	.44	.45	.30	.41	.41	.41	.36	.25	.41
#33 Lake Havasu, Calif.	.30	.44	.41	.39	.41	.41	.44	.40	.39	.40	.34	.36	.39
#30 at Yuma, Ariz.	.11	.11	.11	.18	.12	.18	.22	[illegible]	.20	.14	.13	.14	.16
Dolores River:													
#21 at Bedrock, Colo.	.16	.21	.14	.11	.08	.21	.78	.49	.55	.45	.36	.41	.33
#26 at Gateway, Colo.	.86	1.00	.45	.34	.36	.78	1.80	1.10	1.90	2.40	2.00	1.40	1.20
Green River:													
#28 below Maybell, Colo.	(a)												
Gunnison River:													
#24 above Gunnison, Colo.	(a)												
#25 below Gunnison, Colo.	(a)												
#5 at Grand Junction, Colo.	.08	.05	.05	.08	.06	.10	.10	.19	.12	.11	.05	.08	.09
San Juan River:													
#14 below Farmington, N. Mex.	.03	.04	.04	.03	.05	.06	.09	.05	.09	.04	.04	.04	.05
#148 below Shiprock, N. Mex.	.04	.04	.05	.04	.06	.07	.06	.08	NS	NS	NS	NS	.06
#15 above Mexican Hat, Utah	.05	.06	.08	.06	.04	.06	.11	.11	.10	.09	.09	.08	.08
#16 below Mexican Hat, Utah	.08	.06	.08	.06	.04	.05	.09	.14	.09	.09	.06	.05	.07
San Miguel River:													
#17 above Naturita, Colo.	.04	.01	.04	.05	.04	.06	.05	.06	.08	.06	.04	.03	.05
#18 above Uravan, Colo.	.14	.22	.10	.09	.14	.10	.18	.20	.15	.10	.08	.10	.13
#20 below Uravan, Colo.	.48	.87	.38	.23	.40	.46	1.36	1.04	3.44	2.42	3.88	6.82	1.82

a Discontinued.

NS, no sample.

Table 2. Uranium in surface waters of the Colorado River basin averages January 1965–December 1966—Continued (concentrations μg/liter)

Sampling station number and location	1966												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly average
Animas River:													
#11 above Durango, Colo.	1.1	1.0	1.3	1.1	0.6	1.3	0.3	1.4	0.8	2.9	1.1	0.7	1.1
#12 Colo.-N. Mex. State line	1.9	2.2	0.0	1.4	0.8	0.9	1.4	3.3	1.8	3.6	1.4	2.2	1.9
Colorado River:													
#1 at Silt, Colo.	1.9	2.1	0.0	1.9	0.7	1.2	2.3	2.6	2.7	2.9	2.9	3.2	2.2
#4 at De Beque, Colo.	4.7	2.9	0.6	2.6	0.7	2.0	4.0	3.4	2.6	3.3	3.3	4.3	2.9
#6 at Fruita, Colo.	7.1	6.0	5.6	4.7	3.9	5.0	7.4	9.8	11.0	12.0	10.0	9.4	7.7
#9 above Moab, Utah	8.5	6.2	4.8	4.5	2.4	5.1	11.0	13.0	12.0	12.0	11.0	11.0	8.5
#10 below Moab, Utah	11.0	12.0	5.5	6.3	3.1	4.8	12.0	13.0	12.0	15.0	13.0	15.0	10.2
#31 at Page, Ariz.	4.9	5.1	5.2	5.8	3.7	4.8	3.9	NS	3.9	3.7	NS	4.5	4.6
#32 Lake Mead, Nev.	8.0	7.6	6.3	8.4	8.9	6.0	7.5	7.0	7.3	6.0	5.0	5.0	6.9
#33 Lake Havasu, Calif.	7.5	7.5	7.8	7.6	7.7	7.1	8.0	8.1	6.8	6.6	5.4	7.6	7.3
#30 at Yuma, Ariz.	4.9	6.4	6.6	8.7	9.5	7.0	9.2	7.4	6.7	4.3	3.5	5.0	6.6
Dolores River:													
#21 at Bedrock, Colo.	5.0	4.8	1.8	1.8	0.1	3.5	12.0	8.6	12.0	12.0	13.0	12.0	7.2
#26 at Gateway, Colo.	19.0	17.0	10.0	6.3	5.9	8.0	20.0	31.0	43.0	41.0	45.0	34.0	23.4
Green River:													
#28 below Maybell, Colo.	(a)												
Gunnison River:													
#24 above Gunnison, Colo.	(a)												
#25 below Gunnison, Colo.	(a)												
#5 at Grand Junction, Colo.	18.0	14.0	9.0	4.4	5.3	7.6	12.0	14.0	14.0	14.0	5.6	12.0	10.8
San Juan River:													
#14 below Farmington, N. Mex.	0.8	1.5	0.3	1.2	1.3	0.8	2.8	3.0	1.5	1.6	2.3	4.4	1.8
#148 below Shiprock, N. Mex.	2.4	3.8	0.6	2.4	1.2	2.0	3.5	3.8	NS	NS	NS	NS	2.5
#15 above Mexican Hat, Utah	2.6	2.5	3.3	2.3	1.4	2.7	5.0	5.7	6.7	[illegible]	2.9	5.8	3.7
#16 below Mexican Hat, Utah	2.8	2.8	3.3	2.2	1.5	3.3	5.0	6.5	5.1	3.5	3.5	5.7	3.8
San Miguel River:													
#17 above Naturita, Colo.	3.0	3.5	1.0	1.4	0.4	1.0	2.7	5.1	6.5	1.7	2.9	2.4	2.6
#18 above Uravan, Colo.	5.1	6.7	2.1	1.7	1.0	2.2	3.6	6.0	5.7	3.7	2.9	5.9	3.9
#20 below Uravan, Colo.	4.2	27.5	10.2	2.8	1.4	5.8	18.6	43.5	53.0	5.4	16.3	48.0	21.4

a Discontinued.

NS, no sample.

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta-particle analysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the U.S. Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

An intercomparison of the above networks was performed by Lockhart and Patterson in 1962 and is summarized in the January 1964 issue of *Radiological Health Data*. In addition to those programs presented in this issue, the following programs were previously covered in *Radiological Health Data and Reports*:

Network	Period	Issue
HASL Fallout Network	January–June 1967	March 1968
HASL 80th Meridian Network	Calendar Year 1965	January 1967
Plutonium in Airborne Particulates	April–June 1967	November 1967

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1. Radiation Alert Network
January 1968

National Center for Radiological Health
U.S. Public Health Service

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 73 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform field estimates on the airborne particulate and dried precipitation samples and report the results to appropriate NCRH officials by mail or telephone, depending on levels found. Compilation of the daily field estimates is reported elsewhere on a monthly basis (*1*). A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique during January 1968. Time profiles of gross beta radioactivity in air for eight Radiation Alert Network stations are shown in figure 2.

The field estimates reported by the various stations were within normal limits except that a slight elevation was noted at several stations during the first week or so of January and a field estimate of 21.50 pCi/m³ was reported for Phoenix, Ariz.[1] on January 17, 1968. Fresh fission products were identified[2] on 12 samples collected from January 1–11, by gamma spectroscopy. A total of 51 samples were gamma analyzed.

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[1] Phoenix, Ariz., has recurring elevations in the levels of airborne radioactivity caused by radon and thoron daughter buildup occurring during inversions.

[2] A sample is considered to contain fresh fission products if the gamma spectrum contains a prominent barium-lanthanum-140 peak and a decay rate consistent with a fresh fission product mixture.

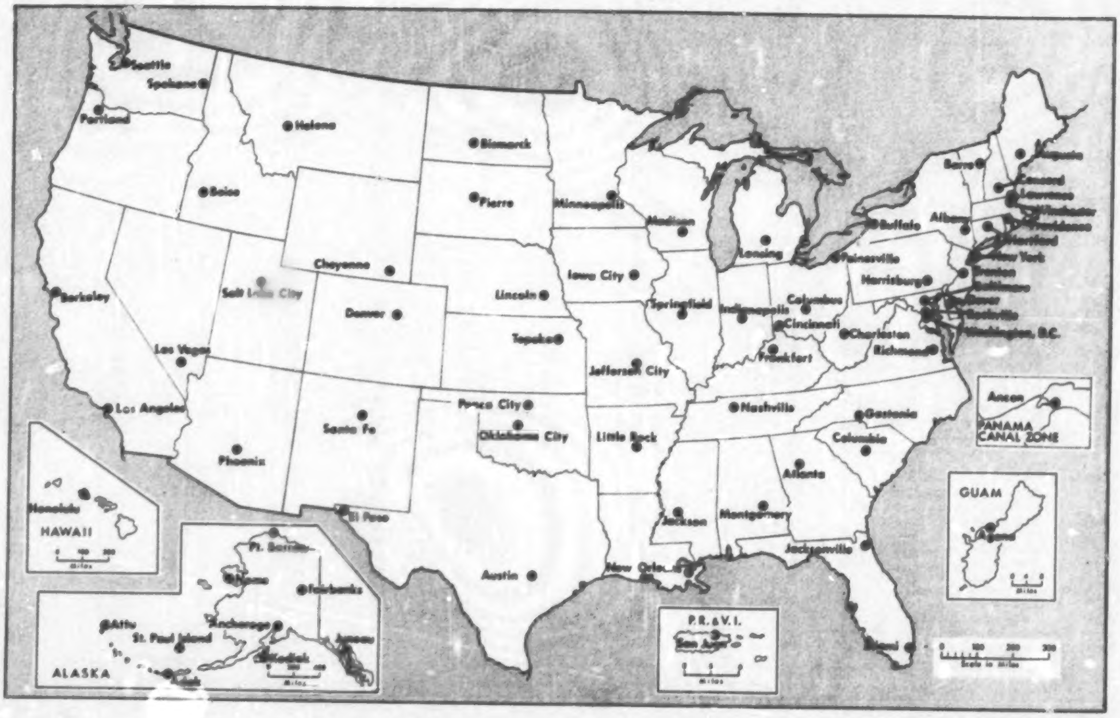
Seattle
Spokane
Portland
Helena
Bismarck
Boise
Pierre
Minneapolis
Madison
Lansing
Buffalo
Albany
Barre
Augusta
Concord
Lawrence
Winchester
Providence
Hartford
New York
Trenton
Baltimore
Dover
Rockville
Washington, D.C.
Painesville
Harrisburg
Cheyenne
Iowa City
Salt Lake City
Berkeley
Lincoln
Denver
Springfield
Indianapolis
Columbus
Cincinnati
Charleston
Richmond
Topeka
Frankfort
Jefferson City
Las Vegas
Los Angeles
Ponca City
Oklahoma City
Santa Fe
Phoenix
Little Rock
Nashville
Gastonia
Columbia
Atlanta
Jackson
Montgomery
Jacksonville
New Orleans
El Paso
Austin
Miami
Honolulu
HAWAII
0 100 200
Miles
Pt. Barrow
Nome
Fairbanks
Anchorage
Attu
St. Paul Island
Kodiak
Juneau
ALASKA
Miles
P.R. & V.I.
San Juan
Miles
Ancon
PANAMA CANAL ZONE
GUAM
Agana
Miles
0 100 200 300
Scale in Miles

Figure 1. Radiation Alert Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, January 1968

Station location		Number of samples		Air surveillance gross beta radioactivity (pCi/m³)			Last profile in RHD&R	Precipitation			
								Total depth (mm)	Field estimation of deposition [b]		
		Air	Pptn	Maximum	Minimum	Average [a]			Number of samples	Total depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	31	7	5.80	0.22	1.90	Nov 66	81	4	36	12
Alaska:	Adak	(b)					June 66	(c)			
	Anchorage	23	4	0.30	.00	0.03	Dec 66	18	4	18	0
	Attu Island	9		.00	.00	.00	July 66	(c)			
	Fairbanks	(b)					Jan 67	(c)			
	Juneau	22	9	.74	.00	.02	Apr 67	119	9	119	0
	Kodiak	22		.91	.00	.38	May 67	(c)			
	Nome	7		.60	.00	.06	Sept 66	(c)			
	Pt. Barrow	19		1.27	.61	.71	Aug 66	(c)			
	St. Paul Island	30		.92	.43	.56	Oct 66	(c)			
Ariz:	Phoenix	24		21.50	1.43	8.74	Apr 67	(c)			
Ark:	Little Rock	14	4	1.15	.29	.65	Dec 66	100	1	16	0
Calif:	Berkeley	25	6	5.11	.00	1.14	May 67	156	6	156	33
	Los Angeles	25	3	5.50	.53	1.65	Sept 66	21	3	21	0
C. Z:	Ancon	10		3.17	.36	2.05	May 67	(c)			
Colo:	Denver	25	2	3.48	.67	1.73	May 67	12	(d)	(d)	(d)
Conn:	Hartford	23	11	1.63	.22	.32	Apr 67	45	11	45	19
Del:	Dover	22		3.08	.14	.52	Nov 66	(c)			
D. C:	Washington	30	9	1.21	.21	.59	Aug 66	54	9	54	53
Fla:	Jacksonville	21	5	1.59	.37	.81	Dec 66	15	5	15	0
	Miami	19	4	.49	.08	.29	Apr 67	49	4	49	0
Ga:	Atlanta	23	4	1.74	.38	1.06	Oct 66	126	(e)	(e)	
Guam:	Agana	2		1.02	.53	.78	Nov 66	(c)			
Hawaii:	Honolulu	31	4	8.53	.31	1.75	July 66	115	(d)	(d)	(d)
Idaho:	Boise	25	1	2.94	.34	1.28	July 66	10	1	10	0
Ill:	Springfield	22	2	1.18	.00	.31	Aug 66	88	(e)	(e)	
Ind:	Indianapolis	21	5	.93	.18	.54	Oct 66	71	5	71	81
Iowa:	Iowa City	27		1.41	.34	.97	May 67	(c)			
Kans:	Topeka	24	3	1.70	.11	.62	Dec 66	7	3	7	2
Ky:	Frankfort	16	5	2.51	.25	.90	Aug 66	26	5	26	30
La:	New Orleans	23	5	1.32	.00	.60	Aug 66	34	1	8	0
Maine:	Augusta	22	10	1.61	.00	.28	Sept 66	102	10	102	25
Md:	Baltimore	22	4	1.46	.00	.67	Apr 67	31	4	31	25
	Rockville	(b)					July 66	61	(d)	(d)	(d)
Mass:	Lawrence	22	4	12.45	.00	.95	Nov 66	56	(e)	(e)	
	Winchester	26	10	1.63	.00	.16	Mar 67	85	10	85	0
Mich:	Lansing	23		1.69	.37	.97	July 66	(c)			
Minn:	Minneapolis	25	6	.64	.17	.24	Nov 66	17	6	17	19
Miss:	Jackson	23	7	1.23	.13	.58	Sept 66	121	7	121	58
Mo:	Jefferson City	25	3	.96	.18	.43	Oct 66	17	3	17	0
Mont:	Helena	23	5	1.89	.23	.65	June 66	22	4	21	26
Nebr:	Lincoln	24	2	3.81	.34	1.37	Oct 66	65	2	65	0
Nev:	Las Vegas	21		4.29	.95	2.69	Jan 67	(c)			
N. H:	Concord	22		4.50	.00	.57	Aug 66	(c)			
N. J:	Trenton	31		1.87	.21	.56	Sept 66	53	4	50	108
N. Mex:	Santa Fe	21	5	1.58	.22	.87	June 66	12	3	12	12
N. Y:	Albany	23	3	1.91	.19	.43	Oct 66	32	8	32	50
	Buffalo	18	8	.50	.00	.29	May 67	(c)			
	New York	23		.97	.35	.46	Mar 67	(c)			
N. C:	Gastonia	17	6	6.40	.36	2.52	May 67	47	(e)	(e)	
N. Dak:	Bismarck	24	3	1.18	.00	.51	Aug 66	7	2	6	0
Ohio:	Cincinnati	22		3.32	.74	1.26	Nov 66	(c)			
	Columbus	21	3	1.22	.00	.38	Sept 66	47	3	47	0
	Painesville	22	10	.78	.21	.41	Apr 67	78	10	78	78
Okla:	Oklahoma City	21	4	6.52	.22	1.18	July 66	37	4	37	0
	Ponca City	22	5	2.09	.07	.52	Apr 67	19	5	19	2
Ore:	Portland	21	13	.89	.00	.33	Oct 66	90	13	90	5
Pa:	Harrisburg	22	1	2.02	.28	1.02	Oct 66	28	(e)	(e)	
P. R:	San Juan	15	2	.00	.00	.00	Sept 66	79	(e)	(e)	
R. I:	Providence	21	2	2.27	.28	.40	July 66	22	(e)	(e)	
S. C:	Columbia	13	6	1.57	.00	.36	Mar 67	177	3	29	3
S. Dak:	Pierre	20		6.02	.76	1.85	Apr 67	(c)			
Tenn:	Nashville	18	10	.99	.31	.62	July 66	89	10	89	0
Tex:	Austin	21	8	7.49	.44	2.78	Nov 66	118	(d)	(d)	(d)
	El Paso	27	3	12.91	1.[illegible]	5.01	Aug 66	14	3	14	0
Utah:	Salt Lake City	31	3	1.08	.2[illegible]	.66	Sept 66	12	1	6	0
Vt:	Barre	23	10	2.78	.00	.49	Dec 66	26	10	26	11
Va:	Richmond	18	7	.96	.22	.87	Dec 66	63	3	7	4
Wash:	Seattle	24	17	3.65	.00	.33	Dec 66	120	(d)	(d)	(d)
	Spokane	23	5	1.89	.31	.85	Nov 66	23	(e)	(e)	
W. Va.	Charleston	23	11	1.07	.24	.45	Mar 67	54	11	54	4[illegible]
Wis:	Madison	22	4	.79	.15	.42	Dec 66	28	4	28	21
Wyo:	Cheyenne	25	1	4.43	.23	1.36	Jan 67	2	1	2	0
Network summary		1,524	294	21.50	0.00	0.96		56	4	35	15

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] Indicates no report received. (air samples submitted without field estimate data are not considered by the data program.)
[c] No precipitation sample collected.
[d] This station is part of the plutonium in precipitation net. Gross beta analysis is not done.
[e] No field estimate.

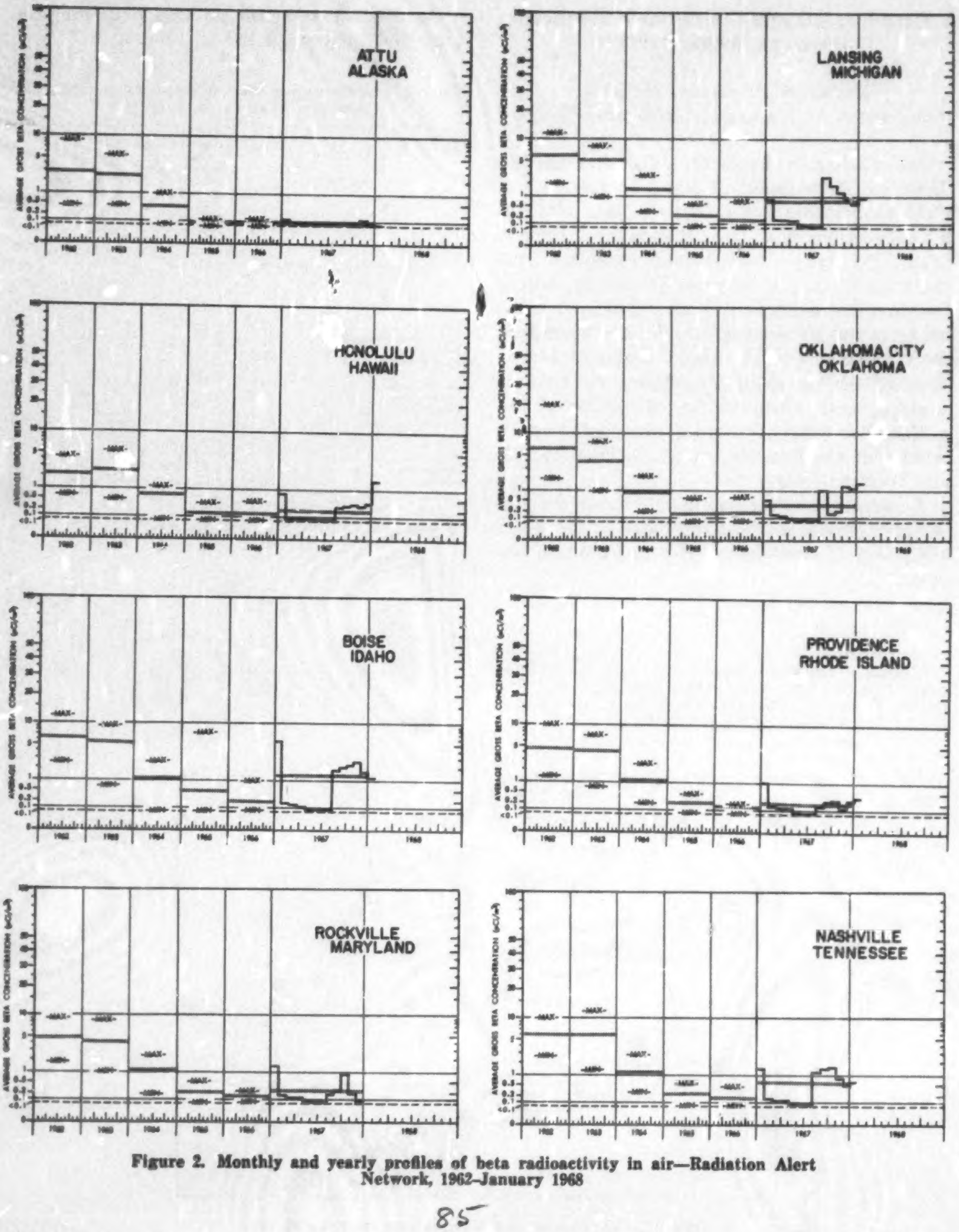

Figure 2. Monthly and yearly profiles of beta radioactivity in air—Radiation Alert Network, 1962–January 1968

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2. Canadian Air and Precipitation Monitoring Program, January 1968[1]

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 3), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*2–6*).

A summary of the sampling procedures and methods of analysis was presented in the April 1968 issue of *Radiological Health Data and Reports.*

Surface air and precipitation data for January 1968 are presented in table 2.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, January 1968

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m^3)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentrations (pCi/liter)	Total deposition (nCi/m^2)
Calgary	30	1.1	0.0	0.2	118	4.2
Coral Harbour	31	0.3	.0	.1	220	2.3
Edmonton	31	1.4	.0	.2	73	2.5
Ft. Churchill	31	.2	.0	.1	75	0.9
Ft. William	30	.7	.0	.1	53	1.1
Fredericton	31	.6	.0	.1	60	4.6
Goose Bay	31	.2	.0	.1	6	.5
Halifax	30	5.7	.0	.3	44	5.6
Inuvik	31	.1	.0	.0	41	1.0
Montreal	31	1.6	.0	.1	56	2.6
Moosonee	31	.8	.0	.1	8	.2
Ottawa	26	1.8	.0	.2	44	3.2
Quebec	31	5.7	.0	.3	46	2.9
Regina	3	.5	.1	.2	90	1.2
Resolute	22	.6	.0	.1	NS	NS
St. John's, Nfld	31	.8	.0	.1	34	4.9
Saskatoon	31	.5	.0	.1	62	1.1
Saulte Ste Marie	26	.4	.0	.1	33	2.4
Toronto	31	.4	.0	.1	81	8.1
Vancouver	31	.4	.0	.1	70	15.3
Whitehorse	31	.2	.0	.1	20	.9
Windsor	31	.3	.0	.1	125	7.7
Winnipeg	31	.4	.0	.1	80	1.9
Yellowknife	31	.3	.0	.1	7	.2
Network summary	694	5.7	0.0	0.1	63	3.3

NS, no sample.

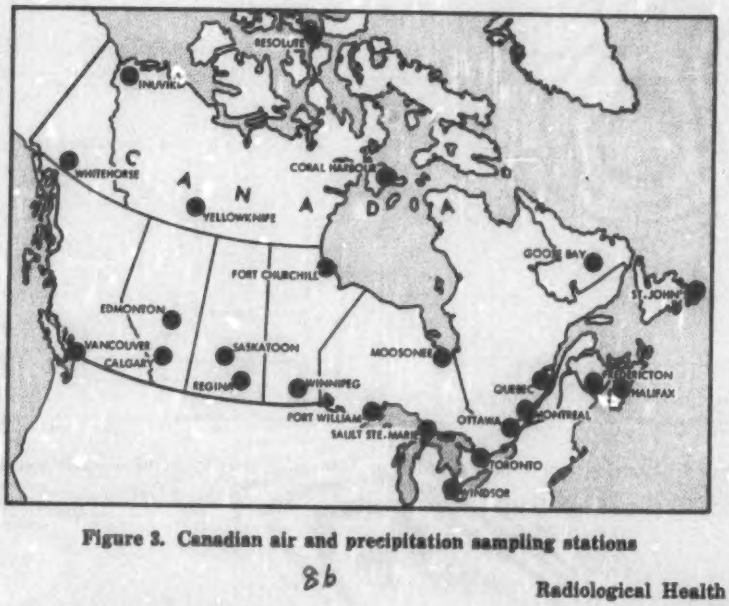
RESOLUTE
INUVIK
WHITEHORSE
C A N A D A
CORAL HARBOUR
YELLOWKNIFE
GOOSE BAY
FORT CHURCHILL
ST. JOHN'S
EDMONTON
VANCOUVER
CALGARY
SASKATOON
REGINA
WINNIPEG
MOOSONEE
QUEBEC
FREDERICTON
HALIFAX
PORT WILLIAM
SAULT STE. MARIE
OTTAWA
MONTREAL
TORONTO
WINDSOR

Figure 3. Canadian air and precipitation sampling stations

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[1] Prepared from information and data in the February 1968 monthly report "Data from Radiation Protection Program," Canadian Department of National Health and Welfare, Ottawa, Canada.

8b

3. Mexican Air Monitoring Program
January 1968

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico was established by the Comisión Nacional de Energía Nuclear (CNEN), México, D.F. From 1952 to 1961, the network was directed by the Institute of Physics of the University of Mexico, under contract to the CNEN.

In 1961, the CNEN appointed its Division of Radiological Protection to establish a new Radiation Surveillance Network. In 1966, the Division of Radiological Protection was restructured and its name changed to Dirección General de Seguridad Radiológica (DRS). The network consists of 16 stations (figure 4), 11 of which are located at airports and operated by airline personnel. The remaining five stations are located at México, D.F.; Mérida; Veracruz; San Luis Potosí; and Ensenada. Staff members of the DRS operate the station at México, D.F., while the other four stations are manned by members of the Centro de Prevision del Golfo de México, the Chemistry Department of the University of Mérida, the Institute de Zonas Desérticas of the University of San Luis Potosí, and the Escuela Superior de Ciencias Marinas of the University of Baja California, respectively.

Sampling

The sampling procedure involves drawing air through a high-efficiency 6 by 9-inch glass-fiber filter for 20 hours a day, 3 or 4 days a week at the rate of 1,000 cubic meters per day using high-volume samplers.

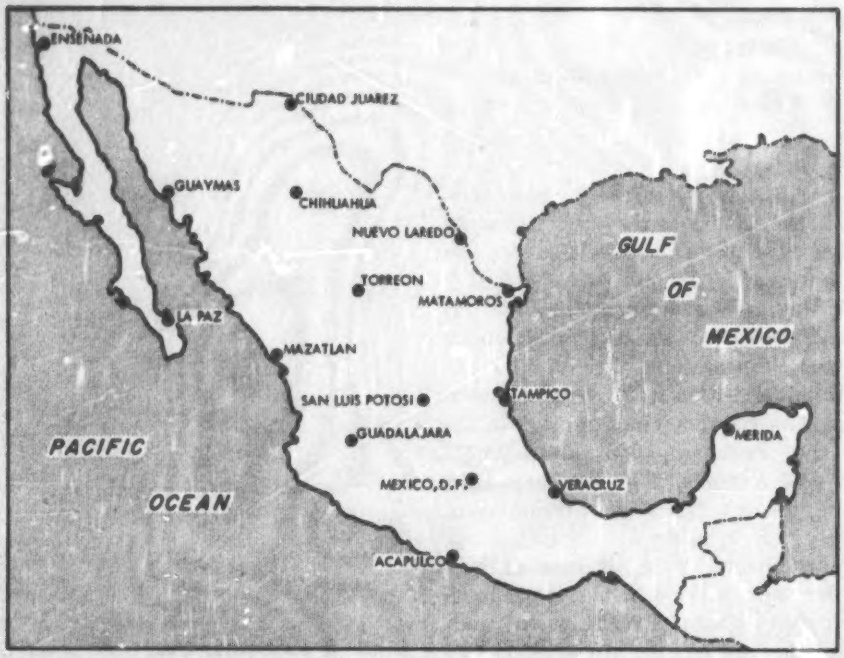
ENSENADA
CIUDAD JUAREZ
GUAYMAS
CHIHUAHUA
NUEVO LAREDO
GULF
OF
MEXICO
TORREON
MATAMOROS
LA PAZ
MAZATLAN
SAN LUIS POTOSI
TAMPICO
GUADALAJARA
MERIDA
PACIFIC
OCEAN
MEXICO, D.F.
VERACRUZ
ACAPULCO

Figure 4. Fallout network sampling stations in Mexico

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After each 20-hour sampling period, the filter is removed and shipped via airmail to the Sección de Radioactividad Ambiental, CNEN, in México, D.F., for assay of gross beta radioactivity, allowing a minimum of 3 or 4 days after collection for the decay of radon and thoron daughters. The data are not extrapolated to the time of collection. Statistically, it has been found that a minimum of five samples per month were needed to get a reliable average radioactivity at each station (7).

The maximum, minimum, and average beta radioactivity in surface air during January 1968, are presented in table 3.

Table 3. Mexican gross beta radioactivity of airborne particulates, January 1968

Station	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average
Acapulco	11	0.7	0.1	0.3
Chihuahua	15	1.7	.1	.8
Ciudad Juares	15	3.0	.1	1.0
Ensenada	10	2.6	.3	1.0
Guadalajara	NS	NS	NS	NS
Guaymas	NS	NS	NS	NS
La Paz	9	.7	.1	.4
Matamoros	NS	NS	NS	NS
Mazatlan	NS	NS	NS	NS
Mérida	NS	NS	NS	NS
México, D.F.	10	3.0	.1	.7
Nuevo Laredo	NS	NS	NS	NS
San Luis Potosí	NS	NS	NS	NS
Tampico	9	1.4	.1	.3
Torreón	13	4.0	.1	1.1
Veracruz	8	1.4	.1	0.3

NS, no sample, temporarily shutdown.

4. Pan American Air Sampling Program January 1968

Pan American Health Organization and *U.S. Public Health Service*

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the U.S. Public Health Service (PHS) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 5. Analytical techniques were described in the January 1968 *Radiological Health Data and Reports*. The January 1968 air monitoring results from the participating countries are given in table 4.

Gross beta radioactivity in air rose slightly above usual levels at several of the stations in the Northern Hemisphere. Fresh fission products were identified by gamma spectroscopy on the samples listed in table 5.

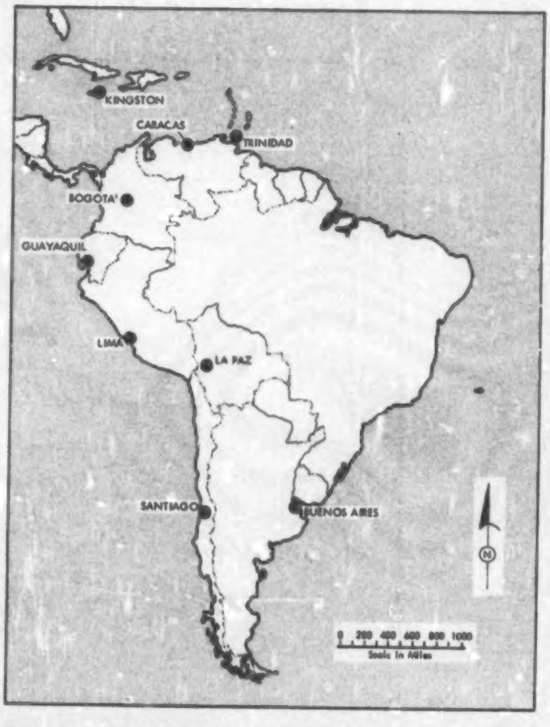

Figure 5. Pan American Air Sampling Program stations

Table 4. Gross beta radioactivity in surface air, Pan American Air Sampling, January 1968

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maxium	Minimum	Average [a]
Argentina:	Buenos Aires	[b]			
Bolivia:	La Paz	19	0.02	0.00	0.01
Chile:	Santiago	27	.04	.02	.03
Colombia:	Bogota	21	.17	.01	.05
Ecuador:	Guayaquil	21	.10	.02	.04
Jamaica:	Kingston	20	.49	.03	.15
Peru:	Lima	21	.05	.02	.03
Venezuela:	Caracas	17	1.36	.04	.18
West Indies:	Trinidad	15	1.26	.02	.27
Pan American summary		161	1.36	0.00	0.08

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

[b] No January samples received.

Table 5. Fresh fission products in Pan American air samples, January 1968

Location		Date (January 1968)	Gross beta radioactivity (pCi/m³)
Colombia:	Bogota	3	0.17
		4	.13
Jamaica:	Kingston	29	.49
		30	.32
Venezuela:	Caracas	4	1.36
		5	.50
		8	.46
		26	.29
West Indies:	Trinidad	4	.42
		5	1.26
		8	.61
		29	.25

REFERENCES

(1) PUBLIC HEALTH SERVICE, NATIONAL CENTER FOR RADIOLOGICAL HEALTH. Environmental radiation surveillance report. NCRH, Standards and Intelligence Branch, Rockville, Md. 20852 (distribution by official request.)

(2) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW-RP-3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

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SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, bovine thyroid sampling, Alaskan surveillance and environmental monitoring around nuclear facilities.

Iodine-131 in Bovine Thyroids, October-December 1967

National Center for Radiological Health
Public Health Service

The National Center for Radiological Health established a Bovine Thyroid Network in October 1964 (*1*). Specimens are collected by the Livestock Slaughter Inspection Division, U.S. Department of Agriculture, and analyzed by gamma-ray spectroscopy for iodine-131 content at the Northeastern Radiological Health Laboratory, Winchester, Mass.

The network consists of collection areas located, so as to cover, as nearly as possible, areas near major nuclear reactors, spent-fuel reprocessing plants and nuclear test sites. The areas covered during this report are shown in figure 1. Details of sampling and analyses have been published earlier (*1*).

The results for October through December 1967 appear in table 1 and are listed chronologically within each State. The iodine-131 levels in thyroids analyzed were nondetectable except for the one sample collected on December 28, 1967, in Cooke County, Texas, which contained 15 pCi iodine-131/gram thyroid.

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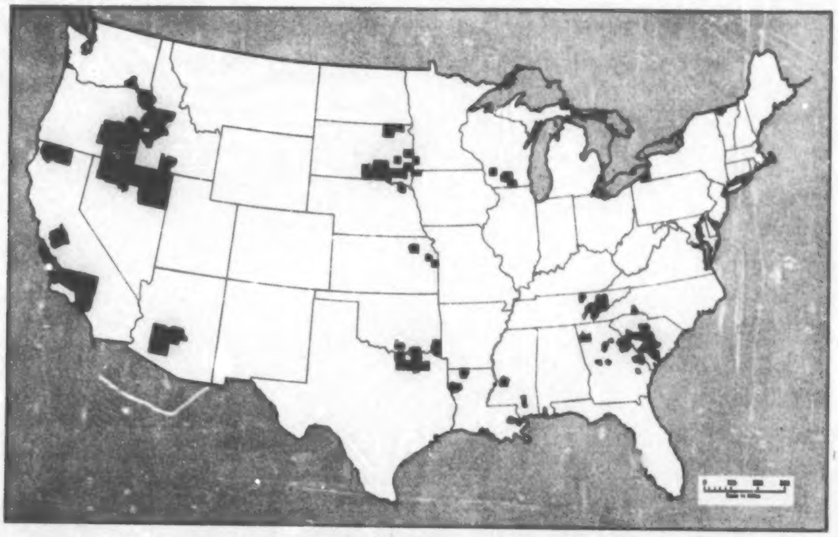

Figure 1. Counties sampled in Bovine Thyroid Network, October-December 1967

Table 1. Iodine-131 in bovine thyroids, October–December 1967

State	County	Date of slaughter	Number of samples	pCi iodine-131/g thyroid
				Average concentration
Arizona	Maricopa	[a] 10/6–12/29	19	[b] ND
California	Kern (2) [c] Los Angeles (2) Merced (1) Monterey (1) San Luis Obispo (3) Siskiyou (1) Stanislaus (2)	[a] 10/4–12/13	12	[b] ND
Georgia	Bartow (2) [c] Bibb (5) Clarke (6) Columbia (2) Evans (6) Floyd (1) Jenkins (1) Lincoln (1) McDuffie (10) Newton (5) Screven (7) Upson (5) Walton (4) Warren (4) Wilkes (2)	[a] 10/3–12/19	61	[b] ND
Idaho	Ada (20) [c] Adams (6) Boise (10) Canyon (2) Jerome (2) Twin Falls (1) Valley (5) Washington (4)	[a] 10/6–12/12	50	[b] ND
Iowa	Lyon	10/25	1	ND
Kansas	Douglas (1) [c] Miami (1) Pohawatomie (2)	[a] 11/9–12/27	4	[b] ND
Louisiana	Claiborne (1) [c] Desoto (1) Red River (1)	[a] 10/13–11/8	3	[b] ND
Minnesota	Pipestone	10/3	6	[b] ND
Mississippi	Forrest (5) Hinds (7)	[a] 10/4–11/9	12	[b] ND
Nebraska	Cedar	11/28	1	ND
Nevada	Elko (10) Humboldt (5)	[a] 10/10–12/1	15	[b] ND
New York	Chatauqua	[a] 10/5–12/20	70	[b] ND
North Carolina	Cleveland	10/3	1	ND
Oklahoma	Bryan (3) [c] Carter (2) McCurtain (1)	[a] 10/10–12/29	6	[b] ND
Oregon	Harney (8) [c] Malheur (15) Wallowa (2)	[a] 10/10–12/13	25	[b] ND
South Carolina	Bamberg (3) [c] Barnwell (9) Calhoun (3) Colleton (3) Fairfield (1) Greenwood (10) Lexington (7) McCormick (1) Orangeburg (12) Richland (5) Saluda (3)	[a] 10/3–12/19	57	[b] ND
South Dakota	Aurora (2) [c] Brookings (4) Brown (7) Brule (16) Charles Mix (6) Douglas (1) Gregory (9) Hutchinson (2) Marshall (1) Miner (3) Minnehaha (2) Tripp (47) Turner (9)	[a] 10/2–12/28	100	[b] ND
Tennessee	Blount (22) [c] Fentress (1) Grainger (6) Jefferson (2) Knox (16) Meigs (1) Monroe (1) Roane (1) Sevier (4) Union (1)	[a] 10/4–12/19	55	[b] ND
Texas	Collin (3) [c] Cooke (2) Denton (2) Fannin (1) Hopkins (3) Hunt (1)	[a] 10/2–12/7	12	[b] ND
	Cooke	12/28	1	15
Vermont	Franklin	[a] 10/24–12/27	50	[b] ND
Washington	Walla Walla	[a] 10/2–12/11	21	[b] ND
Wisconsin	Dane (12) [c] Richland (2) Rock (43)	[a] 10/12–12/28	57	[b] ND

[a] Samples were not collected on all dates during this period, but the interval includes several sampling dates.

[b] The results for this period were for the most part, not detectable. Some randomly scattered positive results were obtained; but these represented barely detectable amounts of iodine-131 in the bovine thyroid (2 to 5 pCi/g).

[c] Numbers in parentheses represent the number of samples collected from that country during the interval indicated. These may have been collected over several dates during the period or on only one date.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–March 1967	August 1967
April–September 1967	February 1968

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Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major AEC installations. The reports include data from rountine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the AEC Manual.[1]

Summaries of data from the environmental radioactivity monitoring reports follow for the Paducah Plant and the Rocky Flats Plant.

---

[1] Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation," contains essentially the standards published in Chapter 0524 of the AEC Manual.

---

1. Paducah Plant

July–December and Calendar Year 1967

Union Carbide Corporation
Paducah, Kentucky

The Paducah Plant is a government-owned gaseous diffusion plant operated by the Nuclear Division of the Union Carbide Corporation for the Atomic Energy Commission. The diffusion plant processes large quantities of relatively pure uranium compounds. The uranium hexafluoride manufacturing plant, a former source of diffusion plant feed, was placed on standby in June of 1964. Parts of the associated uranium metal foundry, usually on standby, are operated infrequently as the need arises. A decontamination and uranium recovery facility operates to prepare equipment for repair and to recover impure or scrap uranium materials. Depleted uranium metal is fabricated into shields, weights, ballasts, or other shapes on a nonroutine basis. The major sources of external penetrating radiation are the daughter products of uranium, thorium–234, and protactinium–234, which may be concentrated by uranium recovery processes or by uranium hexafluoride vaporization. The element uranium can be a physiological hazard only if allowed to enter the body. The chemical toxicity of the uranium processed at the Paducah Plant overshadows any probable biological effects of radiation from this element, thus making it comparable as a physiological hazard to lead, mercury, or other well-known heavy metals.

Because of the necessity for health protection in process areas, the high intrinsic value of uranium, and the desire to maintain a wholesome relationship with neighboring communities and individuals, the Paducah Plant provides confinement and recovery systems at the plant. The environmental monitoring program provides for continuously sampling the air at four stations around the plant perimeter fence, and at five stations located approximately 1 mile outside this fence (figure 1). Big Bayou Creek water is sampled continuously, and grab samples are collected at five locations in the Ohio River. In addition, gamma radiation readings are taken each month at each of the air sampling stations with a Gieger-Mueller type meter at a distance of 3 feet above ground level.

Basic standards

The radiation protection standards observed at the Paducah Plant for exposure to radiation and radioactive materials, both for the in-plant work environment of employees and for offsite exposure of the general population, are those contained in Appendix 0524 of the AEC manual.

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[2] Summarized from "Environmental Concentrations of Radioactive Materials near the Paducah Plant—Report for the Year and Second Half of 1967."

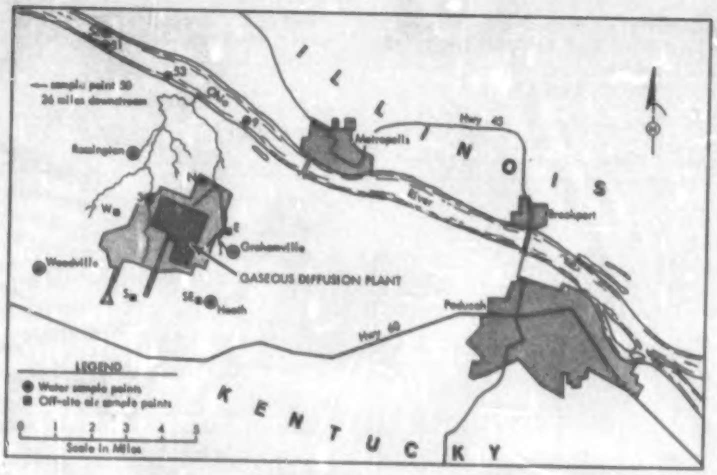

Figure 1. Sampling locations, Paducah Plant

The standards specify that the radiation or radioactive materials outside a controlled area, and which have resulted from operations within that controlled area, shall be such that it is improbable that any individual may receive a dose of external radiation greater than 0.5 rem in any year and that the average exposure of a suitable population sample may not exceed one-third of this dose. To meet this standard, the average concentration of radioisotopes in air or water beyond a controlled area should not exceed one-tenth of the maximum permitted for occupational exposure of 168 hours per week. For the purposes of such control, the concentrations of such radionuclides in air or water may be averaged over periods of time up to 1 year.

Discussion

Data summarizing the environmental concentrations of radioactive materials in air and water and the gamma radiation levels in the vicinity of the Paducah Gaseous Diffusion Plant are presented in tables 1 through 4.

Air samples were collected continuously at each of the four stations at the plant perimeter fence and at five stations about 1 mile outside the plant. Air is filtered at 0.3 cfm through 2-inch diameter membrane filters which are replaced weekly and counted for alpha and beta radioactivity.

Table 1. Uranium concentrations in outdoor air samples, Paducah Plant, July–December and calendar year 1967

Sample location [a]	Number of samples	Uranium alpha radioactivity [b] (pCi/m³)		
		Maximum	Minimum [c]	Mean [d]
July-December 1967: At plant perimeter fence:				
North	26	0.09	<0.02	0.01
East	26	.10	<.02	.02
South	26	.09	<.02	.01
West	26	.09	<.02	.01
Total, July-December 1967	104	.10	<.02	.01
Total, 1967	208	.20	<.02	.01
July-December 1967: About 1 mile outside plant perimeter fence:				
North	26	.09	<.02	.01
East	26	.09	<.02	.01
South	26	.09	<.02	.02
West	26	.10	<.02	.01
Southeast	26	.11	<.02	.02
Total, July-December 1967	130	.11	<.02	.01
Total, 1967	260	.10	<.02	.01

[a] See map in figure 1.

[b] As defined in NBS Handbook 69, paragraph 3.2, a microcurie of recently extracted normal uranium corresponds to 7.57x10⁴ alpha particle disintegrations/second.

[c] The minimum detectable concentration of uranium in air is 0.02 pCi/m³.

[d] The AEC radiation protection standard for natural uranium in air released to the environs beyond a controlled area is 2 pCi/m³.

The average alpha-particle count—interpreted as uranium, the most likely source of radioactivity—of the 234 air samples collected during the second half of 1967 and the 468 air

Table 2. Beta radioactivity in outdoor air samples, Paducah Plant, July–December and calendar year 1967

Sample location [a]	Number of samples	Beta radioactivity (pCi/m^3) Maximum	Minimum [b]	Mean [c]
July-December 1967:				
At plant perimeter fence:				
North	26	0.26	<0.1	0.08
East	26	.31	<.1	.13
South	26	.20	<.1	.10
West	26	.20	<.1	.09
Total, July-December 1967	104	.31	<0.1	.10
Total, 1967	208	2.0	<0.1	.15
July-December 1967:				
About 1 mile outside plant perimeter fence:				
North	26	.33	<.1	.11
East	26	.28	<.1	.10
South	26	.35	<.1	.11
West	26	.36	<.1	.09
Southeast	26	.43	<.1	.12
Total, July-December 1967	130	.43	<0.1	.11
Total, 1967	260	4.3	<0.1	.15

[a] See map in figure 1.

[b] The minimum detectable amount of beta-particle emitters in air is 0.1 pCi/m^3.

[c] The AEC standard, applicable to this table is 1x10^3 pCi/m^3, which is the concentration limit of thorium-234, the daughter product of uranium-238. Insignificant amounts of other daughters are present in freshly refined uranium.

Table 3. Concentrations of uranium in water, Paducah Plant, July–December and calendar year 1967

Sample location [a]	Number of samples	Uranium [b] (pCi/liter) Maximum	Minimum [c]	Mean [d]
July-December 1967:				
Big Bayou Creek 3	26	17	<1	3
Ohio River 9	6	<1	<1	<1
Composite of 50, 51, 52, and 53	6	<1	<1	<1
Year: 1967				
Big Bayou Creek 3	52	33	<1	4
Ohio River 9	12	2	<1	<1
Composite of 50, 51, 52, and 53	12	<1	<1	<1

[a] See map in figure 1.

[b] As defined in NBS Handbook 69, paragraph 3.2, a microcurie of recently extracted normal uranium corresponds ot 7.57x10^4 dis/sec.

[c] The minimum detectable uranium in water is 1 pCi/liter.

[d] The AEC standard for natural uranium in water beyond a controlled area is 2x10^4 pCi/liter.

samples collected during all of 1967 were both less than 1 percent of the AEC standard set for individuals residing in the vicinity of a controlled area. The mean beta-particle count of the same samples were 0.01 percent of the standard for the second half of 1967 and 0.02 percent for the year of 1967.

Table 4. Concentration of beta-particle emitters in water, Paducah, July–December and calendar year 1967

Sample location [a]	Number of samples	Beta-particle emitters (pCi/liter) Maximum	Minimum [b]	Mean [c]
July-December 1967:				
Big Bayou Creek 3	26	700	<100	<100
Ohio River 9	6	100	<100	<100
Composite of 50, 51, 52, and 53	6	<100	<100	<100
Year 1967:				
Big Bayou Creek 3	52	700	<100	<100
Ohio River 9	12	100	<100	<100
Composite of 50, 51, 52, and 53	12	100	<100	<100

[a] See map in figure 1.

[b] The minimum detectable amount of beta-particle emitters in water is 100 pCi/liter.

[c] The AEC standard for the immediate daughter products of uranium in water released to the environs is 2x10^4 pCi/liter.

The average uranium analyses of weekly water samples collected continuously from the Big Bayou Creek during the second half of 1967 and during all of 1967 were both 0.02 percent of the AEC standard for water beyond a controlled area. The results of the uranium analyses for each of the 12 grab samples collected at monthly intervals from the Ohio River below the plant were less than 0.01 percent of the AEC standard.

The concentration of beta-particle emitters in the Big Bayou Creek averaged less than 0.5 percent of the AEC standard for the decay products of uranium-238 during the second half of 1967 and for the year of 1967. The beta radioactivity of the Ohio River was below the minimum detectable level during the second half of 1967, and the results of all samples during the year averaged less than 0.5 percent of the standard for uranium-238 decay products.

External gamma radiation in the vicinity of the Paducah Plant averaged 0.02 mR/hr at all sampling stations for July–December 1967 and the calendar year 1967.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1966 and calendar year 1966	July 1967
January–June 1967	January 1968

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2. Rocky Flats Plant
July–December 1967[3]

Dow Chemical Company
Golden, Colorado

The Rocky Flats Plant (RFP) is engaged in routine production operations involving plutonium and uranium under contract to the Atomic Energy Commission. Its location relative to population centers is shown in figure 2. To assure properly controlled release of radioactive materials to the environment, periodic samples of air, water, and vegetation are analyzed for gross alpha radioactivity. The most abundant radioactive material involved in the process is plutonium.

The plant is located about 15 miles northwest of Denver. The surface stratum in this area consists of gravel washed out of the highly mineralized front range of the Rocky Mountains, where heterogeneous low-level deposits of uranium, thorium, and radium exist in the soil. These materials are measurable in most samples of air, water, and vegetation.

Air

Continuous air samples were collected at Coal Creek Canyon, Marshall, Boulder, Lafayette, Broomfield, Wagner School, Golden, Denver, and Westminster. The monthly average long-lived gross alpha radioactivity shown in table 5 are believed to result from naturally occurring materials. All values are less than the AEC standard of 0.04 pCi/m^3 for mixtures of unidentified radionuclides.

Table 5. Long-lived gross alpha radioactivity in airborne particulates, RFP environs, July–December 1967

Period (1967)	Average concentration (pCi/m^3)
July	0.6×10^{-3}
August	2.0×10^{-3}
September	0.6×10^{-3}
October	0.5×10^{-3}
November	0.3×10^{-3}
December	0.3×10^{-3}

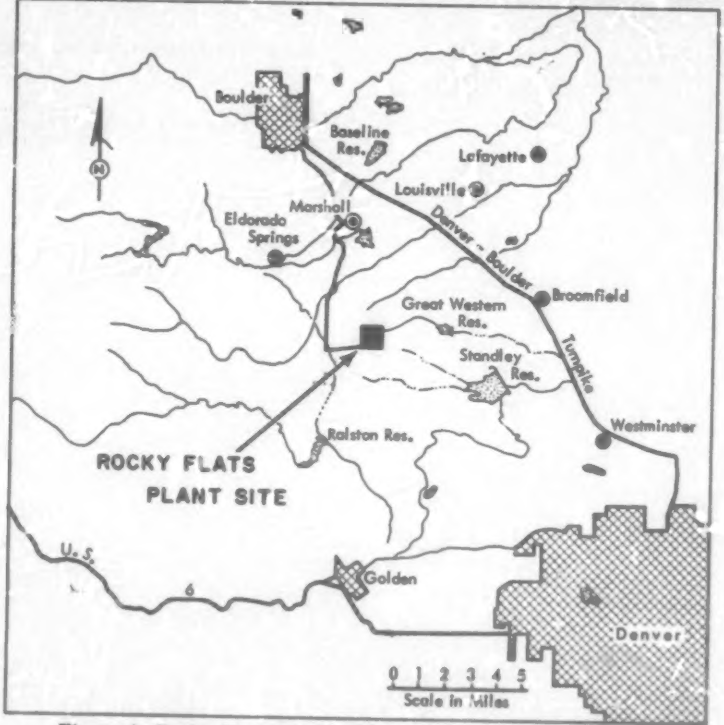
Boulder
Baseline Res.
Lafayette
Louisville
N
Marshall
Eldorado Springs
Denver - Boulder Turnpike
Broomfield
Great Western Res.
Standley Res.
Westminster
Ralston Res.
ROCKY FLATS PLANT SITE
U.S. 6
Golden
Denver
0 1 2 3 4 5
Scale in Miles

Figure 2. Rocky Flats Plant and environs near Denver, Colo.

---

[3] Summarized from "Environmental Survey, July–December 1967," The Dow Chemical Company, Rocky Flats Division, Golden, Colo.

Water

Regular water samples were obtained monthly except during the winter months from four reservoirs in the area of the Rocky Flats Plant. The results of alpha radioactivity analyses performed on these samples are given in table 6. The analytical results for water samples obtained during the summer collection period from outlying streams and lakes are presented in table 7. For comparison purposes, the AEC standard for mixtures of unidentified radionuclides in water is 10 pCi/liter.

Table 6. Alpha radioactivity in water, RFP environs July–December 1967

Reservoir	Number of samples	Average concentration (pCi/liter)
Great Western	5	1.4
Standley	5	2.4
Baseline	5	0.8
Ralston	4	6.4

Table 7. Alpha radioactivity in raw surface water, RFP environs, June and October 1967

Collection period 1967	Number of samples	Average concentration (pCi/liter)
June	37	1.5
October	27	1.7

Vegetation

During June, July, and October 1967, 140 samples of vegetation were collected in the vicinity of Rocky Flats Plant at locations up to 18 miles distant from the plant. Gross alpha-radioactivity counts were made on the samples. The results are reported in table 8.

Table 8. Alpha radioactivity in vegetation, RFP environs June–July, October 1967

Collection period (1967)	Distance from plant	Number of samples	Average concentration (pCi/kg dry weight)
June-July	Less than 3 miles	56	91
	3 to 18 miles	44	70
October [a]	Less than 3 miles	36	120
	3 to 18 miles	4	60

[a] Additional samples collected October 1967, will be reported in subsequent reports.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1966	May 1967
January–June 1967	January 1968

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Reported Nuclear Detonations, April 1968

The U.S. Atomic Energy Commission announced on April 24, 1968, that the United States had recorded seismic signals originating from the Soviet underground nuclear test area in the Semipalatinsk region. The signals were equivalent to those of a nuclear test in the low yield range (less than 20 kilotons TNT equivalent).

Two underground nuclear tests of low-intermediate yield (20 to 200 kilotons TNT equivalent) were conducted by the U.S. Atomic Energy Commission at its Nevada Test Site on April 10 and 18, 1968.

On April 23, 1968, an underground nuclear test of low yield (less than 20 kilotons TNT equivalent) was conducted as part of the Department of Defense Vela Uniform Program to improve methods of detecting, identifying and locating underground nuclear detonations. The experiment, called "Scroll" was designed to provide information on the transmission of earth shock and long range seismic signals from an underground nuclear explosion in a low-moisture content and high-porosity medium. The explosion was 750 feet underground in a medium called low density tuff—a kind of disintegrated volcanic rock.

On April 26, 1968, a nuclear test of about a megaton in yield was conducted underground by the U.S. Atomic Energy Commission at its Nevada Test Site. All indications are that performance of this important test and its effects were in accordance with expectations. There was no release of radioactive materials to the atmosphere. As previously stated by the U.S. Atomic Energy Commission, public health and safety has been and continues to be a paramount consideration in conducting underground testing programs.

ERRATUM

Erratum to figure 4 in article "Gross Radioactivity of the Solids in Selected Surface Waters of the United States, 1961–1965" by Elmo C. Julian in *Radiological Health Data and Reports*, Vol. 9, January 1968, pp. 1–12.

Page 9, Figure 4, the caption to the ordinate axis on the left-hand side of the figure should read, "pCi x 10."

☆U. S. GOVERNMENT PRINTING OFFICE : 1968 302-808/10

RADIOLOGICAL HEALTH DATA AND REPORTS

Volume 9, Number 6, June 1968

In August 1959, the President directed the Secretary of Health, Education, and Welfare, to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels such as natural background, radiography, medical and industrial uses of isotopes and X rays, and fallout. The Department delegated this responsibility to the National Center for Radiological Health, Public Health Service.

Radiological Health Data and Reports, a monthly publication of the Public Health Service, includes data and reports provided to the National Center for Radiological Health by Federal agencies, State health departments, universities, and foreign governmental agencies. Pertinent original data and interpretive manuscripts are invited from investigators.

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Department of Defense
Department of Interior
Department of Agriculture
Department of Commerce
Department of Health, Education, and Welfare
Atomic Energy Commission

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Data

SECTION I. MILK AND FOOD

In the determination of the internal exposure to man from environmental radiation sources, primary interest centers on radionuclides in the diet. Federal and State agencies are involved in efforts to monitor continuously the dietary intake of radionuclides. The most direct measure of radionuclide intake would be obtained through radioanalysis of the total diet. Difficulties in obtaining specific dietary data impede this approach. An alternate method entails the use of indicator foods to arrive at an estimate of the total dietary radionuclide intake.

Fresh milk is one such indicator food. It is consumed by a large segment of the U.S. population and contains most of the biologically significant radionuclides which appear in the diet. It also is one of the major sources of dietary intake for the short-lived radionuclides. For these reasons, fresh milk is the single food item most often used in estimating the intake of selected radionuclides by the general population and/or specific population groups. In the absence of specific dietary information, it is possible to approximate the total daily dietary intake of selected radionuclides as being equivalent to the intake represented by the consumption of 1 liter of fresh milk.

The Federal Radiation Council (FRC) has developed Radiation Protection Guides (RPG's) for controlling normal peacetime nuclear operations, assuming continuous exposure from intake by the population at large (*1–3*). The RPG's do not and cannot establish a line which is safe on one side and unsafe on the other; they do provide an indication of when there is a need to initiate careful evaluation of exposure (*3*). Additional guidelines are provided by the FRC Protective Action Guides (*4*) and by the International Commission on Radiological Protection (*5, 6*).

Data from selected national, international, and State milk and food surveillance activities are presented herein. An effort has been made to present a cross-section of routine sampling programs which may be considered of a continuing nature. Routine milk sampling has been defined as one or more samples collected per month.

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(*6*) INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Recommendation of the International Commission on Radiological Protection, Report No. 6. Pergamon Press, New York, N.Y. (1965).

National and International Milk Surveillance

As part of continuing efforts to quantitatively monitor man's exposure to radionuclides, various national and international organizations routinely monitor radionuclide levels in milk. In addition to those programs reported below, *Radiological Health Data and Reports* coverage includes:

Program	Period reported	Last presented
Radiostrontium in milk, *HASL*	July–December 1966	September 1967

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1. Pasteurized Milk Network February 1968

National Center for Radiological Health and *National Center for Urban and Industrial Health, PHS*

The Public Health Service's Pasteurized Milk Network (PMN) is designed to provide nationwide surveillance of radionuclide concentrations in milk through sampling from major milk production and consumption areas. The present network of 63 stations (figure 1) provides data on milk in every State, Washington, D. C., the Canal Zone, and Puerto Rico. The most recent description of the sampling and analytical procedures employed by the PMN appeared in the January 1968 issue of *Radiological Health Data and Reports* (*1*). Reference should also be made to the February 1968 issue (*2*), in which several changes in the interpretation and reporting of data were introduced.

Table 1. Analytical errors associated with determinations of radionuclide concentrations in a milk sample

Nuclide	Concentration (pCi/liter)	Error [a] (pCi/liter)	Concentration (pCi/liter)	Error [a] (percent of concentration)
Strontium-89	<50	5	≥50	10
Strontium-90	<20	2	≥20	10
Iodine-131	<100	10	≥100	10
Cesium-137	<100	10	≥100	10
Barium-140	<100	10	≥100	10

[a] Two standard deviations.

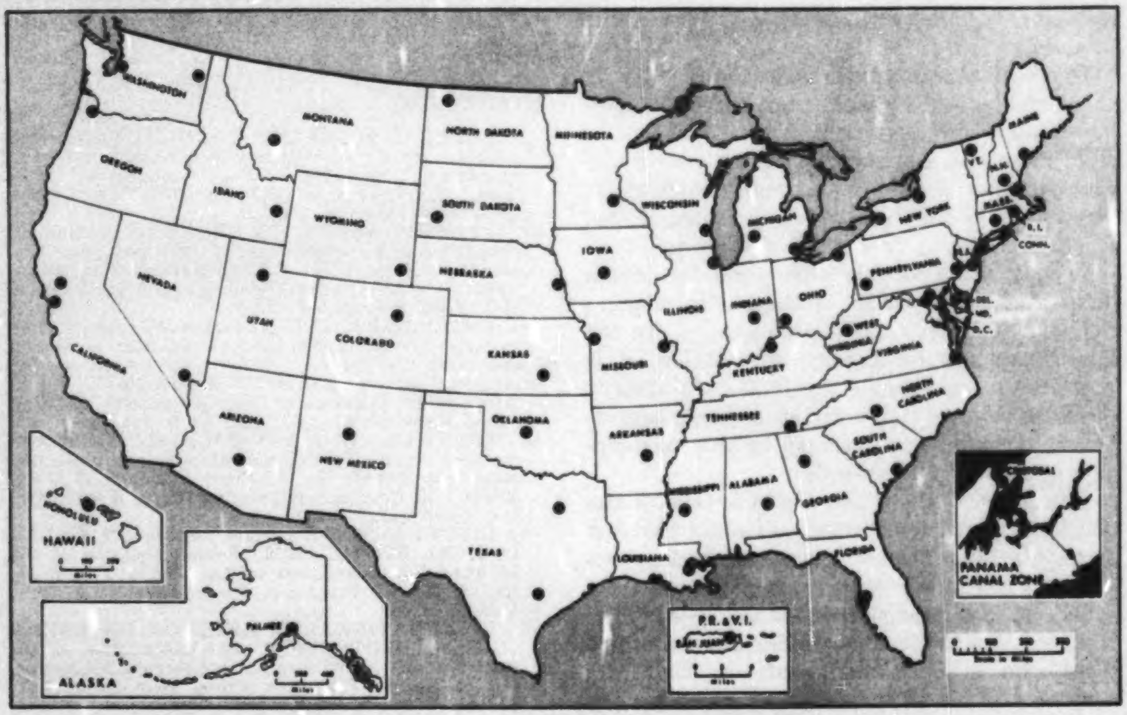
WASHINGTON
OREGON
MONTANA
IDAHO
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
WYOMING
WISCONSIN
MICHIGAN
NEW YORK
MAINE
VT.
N.H.
MASS.
R.I.
CONN.
NEVADA
UTAH
COLORADO
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
N.J.
DEL.
MD.
D.C.
WEST VIRGINIA
VIRGINIA
CALIFORNIA
KANSAS
MISSOURI
KENTUCKY
NORTH CAROLINA
TENNESSEE
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
SOUTH CAROLINA
MISSISSIPPI
ALABAMA
GEORGIA
TEXAS
LOUISIANA
FLORIDA
HONOLULU
HAWAII
ALASKA
PALMER
P.R. & V.I.
CRISTOBAL
PANAMA CANAL ZONE

Figure 1. Pasteurized Milk Network sampling stations

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Table 1 shows the approximate analytical errors (including counting error) associated with determinations of radionuclide concentrations in milk. These errors were determined by comparing results of a large number of replicate analyses. Table 2 contains averages for February 1968 and 12-month averages for the period March 1967 through February 1968. The 12-month average enables evaluations of population exposure with respect to the guidance provided by the Federal Radiation Council which suggests average total daily intakes, "averaged over periods of the order of a year," as an appropriate criterion (*3*). The average radionuclide concentrations are based on results obtained from samples collected weekly. Whenever weekly concentrations were less than or equal to the appropriate minimum detectable levels, zero was used for averaging purposes (*2*). At very low radionuclide concentrations this often results in averages lower than the minimum detectable concentration for a single sample, but any positive value reflects at least one weekly sample which was above the minimum detectable level. The minimum detectable concentration is defined as the measured concentration equal to the two-standard deviation analytical error. Accordingly, the minimum detectable concentrations in units of pCi/liter are: strontium-89, 5; strontium-90, 2; iodine-131, cesium-137, and barium-140, 10.

The average strontium-90 concentrations in pasteurized milk from selected cities are presented in figure 2.

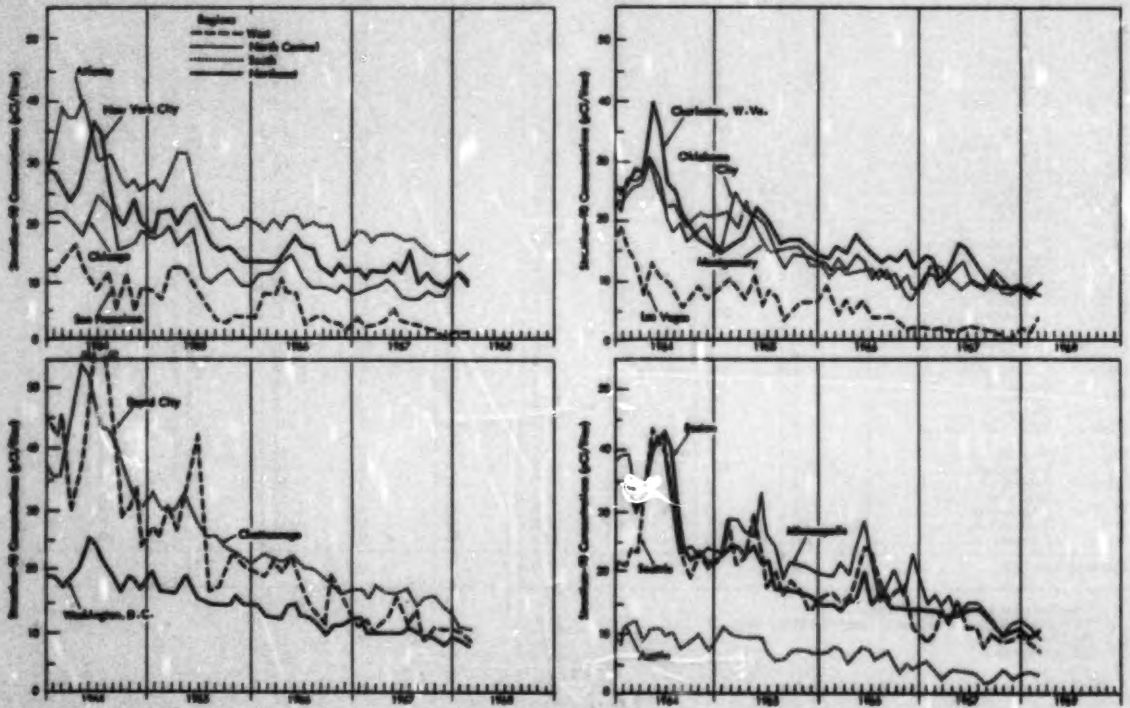

Figure 2. Strontium-90 concentrations in pasteurized milk, 1963–February 1968

Table 2. Average concentrations of radionuclides in milk for February 1968 and the 12-month period, March 1967–February 1968 [a]

Sample location		Radionuclide concentration (pCi/liter)									
		Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
		Mar 1967-Feb 1968	Feb 1968	Mar 1967-Feb 1968	Feb 1968	Mar 1967-Feb 1968	Feb 1968	Mar 1967-Feb 1968	Feb 1968	Mar 1967-Feb 1968	Feb 1968
Ala:	Montgomery	0	0	10	10	0	0	14	14	0	0
Alaska:	Palmer	1	4	6	5	0	0	18	6	1	0
Ariz:	Phoenix	0	0	2	3	0	0	1	0	0	0
Ark:	Little Rock	0	0	22	21	0	0	19	20	0	0
Calif:	Sacramento	2	0	2	1	0	0	5	5	0	0
	San Francisco	2	0	3	1	0	0	4	10	1	0
C. Z:	Cristobal	0	0	2	2	0	0	18	10	0	0
Colo:	Denver	1	0	6	5	1	0	6	10	0	0
Conn:	Hartford	NA	NA	9	8	0	0	17	13	0	0
Del:	Wilmington	NA	NA	11	8	0	0	12	5	0	0
D. C:	Washington	0	0	10	8	0	0	8	7	0	0
Fla:	Tampa	0	0	8	9	0	0	73	65	0	0
Ga:	Atlanta	0	0	15	14	0	0	23	23	0	0
Hawaii:	Honolulu	0	2	4	2	1	0	8	4	1	0
Idaho:	Idaho Falls	1	2	6	5	0	0	8	0	0	0
Ill:	Chicago	NA	NA	9	9	0	0	13	13	0	0
Ind:	Indianapolis	NA	NA	8	7	0	0	9	14	0	0
Iowa:	Des Moines	1	0	7	7	0	0	7	6	0	0
Kans:	Wichita	1	0	9	9	0	0	4	1	0	0
Ky:	Louisville	0	0	13	10	0	0	7	7	1	0
La:	New Orleans	1	0	24	19	0	0	26	17	0	0
Maine:	Portland	NA	NA	12	10	0	0	33	28	0	0
Md:	Baltimore	0	0	11	8	0	0	9	6	0	0
Mass:	Boston	NA	NA	12	11	0	0	26	22	0	0
Mich:	Detroit	NA	NA	9	8	0	0	14	17	0	0
	Grand Rapids	NA	NA	10	17	0	0	17	14	0	0
Minn:	Minneapolis	1	0	13	10	0	0	13	12	0	3
Miss:	Jackson	1	0	18	17	0	0	15	9	0	0
Mo:	Kansas City	2	1	9	8	0	0	4	15	1	8
	St. Louis	2	3	10	8	0	0	7	10	0	0
Mont:	Helena	1	4	6	4	0	0	8	0	0	0
Nebr:	Omaha	1	5	8	6	0	0	5	5	0	3
Nev:	Las Vegas	0	0	2	4	0	0	3	5	0	0
N. H:	Manchester	NA	NA	14	11	0	0	41	27	0	0
N. J:	Trenton	NA	NA	9	8	0	0	13	12	0	0
N. Mex:	Albuquerque	0	0	2	1	0	0	2	3	0	0
N. Y:	Buffalo	NA	NA	8	7	0	0	13	10	0	0
	New York City	NA	NA	11	8	0	0	15	15	0	0
	Syracuse [b]	NA	NS	7	NS	0	NS	12	NS	0	NS
N. C:	Charlotte	0	0	17	15	1	0	14	2	0	0
N. Dak:	Minot	3	3	13	10	0	0	13	8	0	0
Ohio:	Cincinnati	NA	NA	9	9	0	0	8	5	0	0
	Cleveland	NA	NA	10	8	0	0	12	8	0	0
Okla:	Oklahoma City	0	0	10	10	0	0	5	4	0	0
Oreg:	Portland	2	3	8	5	1	0	14	15	0	3
Pa:	Philadelphia	NA	NA	9	9	0	0	11	9	0	0
	Pittsburgh	NA	NA	13	14	0	0	12	14	0	0
P. R:	San Juan	0	0	5	4	0	0	13	9	0	0
R. I:	Providence	NA	NA	11	7	0	0	22	13	0	0
S. C:	Charleston	0	0	15	13	0	0	31	33	0	0
S. Dak:	Rapid City	2	0	11	9	0	0	10	6	0	0
Tenn:	Chattanooga	0	0	15	11	0	0	15	10	0	0
	Memphis	0	0	12	8	0	0	5	9	0	0
Tex:	Austin	0	0	4	4	0	0	4	5	0	0
	Dallas	0	0	9	7	0	0	6	6	0	0
Utah:	Salt Lake City	0	3	6	5	0	0	11	10	0	0
Va:	Norfolk	0	0	10	11	0	0	15	5	0	0
Vt:	Burlington	NA	NA	12	9	0	0	12	11	0	0
Wash:	Seattle	2	0	10	7	0	0	26	15	0	0
	Spokane	1	7	9	7	0	0	15	12	0	0
W. Va:	Charleston	0	0	11	8	0	0	7	0	0	0
Wis:	Milwaukee	NA	NA	8	8	0	0	14	7	0	0
Wyo:	Laramie	0	0	5	5	0	0	5	7	0	3
Network average		0	1	10	8	0	0	14	10	0	0

[a] See text for averaging procedures.

[b] 12-month averages represent only 9 months data.

NA, no analysis.

NS, no sample.

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2. Canadian Milk Network
February 1968[1]

Radiation Protection Division
Department of National Health and Welfare

Since November 1955, the Radiation Protection Division of the Department of National Health and Welfare has been monitoring milk for radionuclide concentrations. Powdered milk was originally sampled, but liquid whole milk has been sampled since January 1968. At present, 16 milk sampling stations (figure 3) are in operation. Their locations coincide with air and precipitation sampling stations.

Milk samples are collected three times a week from selected dairies and are combined into weekly composites. The contribution of each dairy to the composite sample is directly proportional to the liquid volume of sales. Weekly spot check analyses are made for iodine-131, and monthly composites are analysed for strontium-90, cesium-137, and stable calcium and potassium. The analytical procedures were outlined in the April 1968 issue of *Radiological Health Data and Reports* (4).

The February 1968 monthly average strontium-90, cesium-137, and stable calcium and potassium concentrations in Canadian whole milk are presented in table 3. Iodine-131 and strontium-89 concentrations were below minimum detectable levels.

Table 3. Stable elements and radionuclides in Canadian whole milk, February 1968

Station	Calcium (g/liter)	Potassium (g/liter)	Strontium-90 (pCi/liter)	Cesium-137 (pCi/liter)
Calgary	1.13	1.5	9	17
Edmonton	[illegible]	1.5	8	24
Ft. William	1.07	1.5	12	24
Fredericton	1.08	1.5	18	26
Halifax	1.06	1.5	9	24
Montreal	1.07	1.4	10	22
Ottawa	1.10	1.5	9	24
Quebec	1.08	1.6	13	24
Regina	1.01	1.4	8	14
St. John's, Nfld	1.16	1.5	22	39
Saskatoon	1.11	1.4	7	21
Saulte Ste. Marie	1.04	1.4	15	30
Toronto	1.16	1.5	5	21
Vancouver	1.17	1.6	12	40
Windsor	1.12	1.4	5	18
Winnipeg	1.13	1.5	7	29

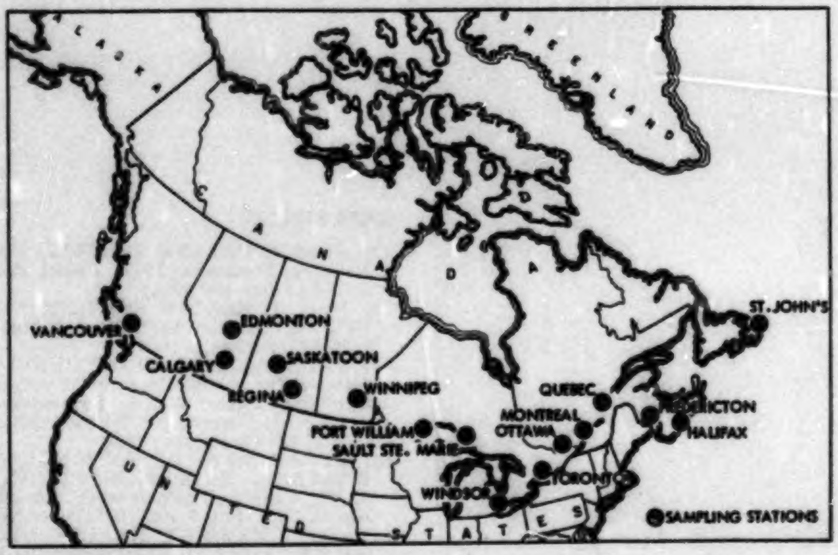
ALASKA
GREENLAND
CANADA
UNITED STATES
VANCOUVER
EDMONTON
CALGARY
SASKATOON
REGINA
WINNIPEG
PORT WILLIAM
SAULT STE. MARIE
WINDSOR
TORONTO
OTTAWA
MONTREAL
QUEBEC
FREDERICTON
HALIFAX
ST. JOHN'S
SAMPLING STATIONS

Figure 3. Canadian milk sampling stations

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[1] Prepared from March 1968 monthly report "Data from Radiation Protection Programs," Canadian Department of National Health and Welfare, Ottawa, Canada.

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3. Pan American Milk Sampling Program February 1968

Pan American Health Organization and *U.S. Public Health Service*

The Pan American Health Organization (PAHO) in collaboration with the U.S. Public Health Service (PHS), furnishes assistance to health agencies in the American Republics in developing national radiological health programs.

Under a joint agreement between agencies, air and milk sampling activities are conducted by a number of PAHO member countries (figure 4). Results of the milk sampling program are presented below. Further information on the sampling and analytical procedures employed was presented in the December 1966 issue of *Radiological Health Data and Reports* (*5*).

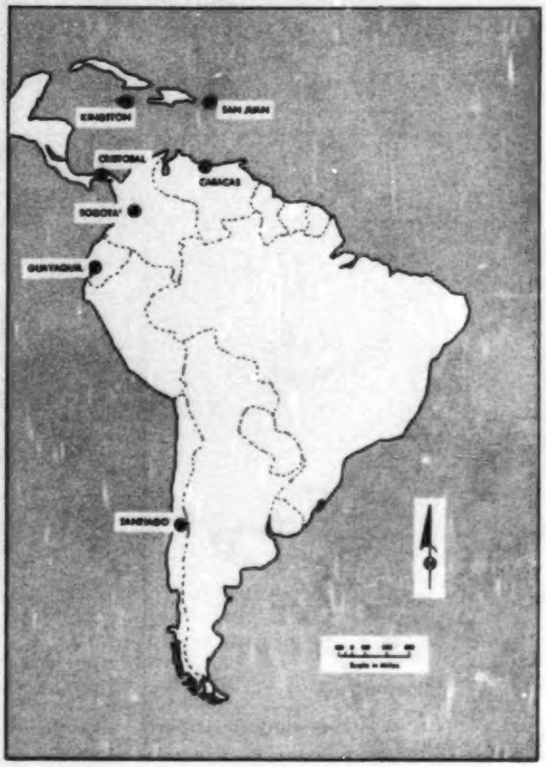

Figure 4. Pan American Milk Sampling Program stations

Table 4 presents stable potassium, strontium-90 and cesium-137 monthly concentrations for February 1968.

Table 4. Stable elements and radionuclide concentrations in Pan American milk,[a] February 1968

Sampling stations		Number of samples	Potassium (g/liter)	Strontium-90 [b] (pCi/liter)	Cesium-137 [b] (pCi/liter)
Chile:	Santiago	1	1.7	0	0
Colombia:	Bogota	1	1.3	0	20
Ecuador:	Guayaquil	1	1.6	0	0
Jamaica:	Mandeville	1	1.4	0	75
Venezuela:	Caracas	1	1.4	3	0
Canal Zone:	Cristobal [c]	5	1.6	2	10
Puerto Rico:	San Juan [c]	6	1.6	4	9

[a] Strontium-89 analyses was ≤5 pCi/liter, and iodine-131 and barium-140 were ≤10 pCi/liter for all samples.

[b] Single sample analyses for strontium-90 was ≤2 pCi/liter and cesium-137 ≤10 pCi/liter and are reported as 0.

[c] For comparison, the radionuclide concentrations in Pasteurized Milk Network samples collected at Cristobal, Canal Zone, and San Juan, Puerto Rico, are presented.

REFERENCES

(*1*) PUBLIC HEALTH SERVICE. Pasteurized Milk Network, September 1967. Radiol Health Data Rep 9:20–23 (January 1968).

(*2*) PUBLIC HEALTH SERVICE. Pasteurized Milk Network, October 1967. Radiol Health Data Rep 9:86–89 (February 1968).

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of radiation protection standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1960).

(*4*) DEPARTMENT OF NATIONAL HEALTH AND WELFARE, RADIATION PROTECTION DIVISION. Canadian milk network, August 1966. Radiol Health Data Rep 7:702–703 (December 1966).

(*5*) PAN AMERICAN HEALTH ORGANIZATION and U.S. PUBLIC HEALTH SERVICE. Pan American Milk Sampling Program, August 1966. Radiol Health Data Rep 7:704–705 (December 1966).

State Milk Surveillance Activities

Considerable progress has been made by the State health departments in initiating or expanding environmental surveillance activities in radiological health. Many of the States now have comprehensive environmental surveillance programs and self-sustaining radiological health laboratories.

The continuing efforts of State health departments in the analysis and monitoring of radionuclides in milk complement Federal milk surveillance activities. State milk surveillance activities are continually undergoing developmental changes. The results presented herein are representative of current surveillance activities directed at the use of milk as an indicator of dietary intake of radioactivity.

Figure 1 shows the States which report milk surveillance activities in *Radiological Health Data and Reports.* States having programs appearing in this issue are highlighted in the figure. Following is a summary of previously covered State programs, their reporting period, and issue of appearance.

State milk network	Period reported	Last presented
Colorado	October–December 1967	April 1968
Connecticut	October–December 1967	May 1968
Florida	October–December 1967	April 1968
Indiana	October–December 1967	May 1968
Iowa	October–December 1967	May 1968
Michigan	October–December 1967	May 1968
Minnesota	October–December 1967	May 1968
New York	October–December 1967	May 1968
Oklahoma	October–December 1967	April 1968
Pennsylvania	October–December 1967	May 1968
Tennessee	October–December 1967	April 1968
Texas	October–December 1967	April 1968

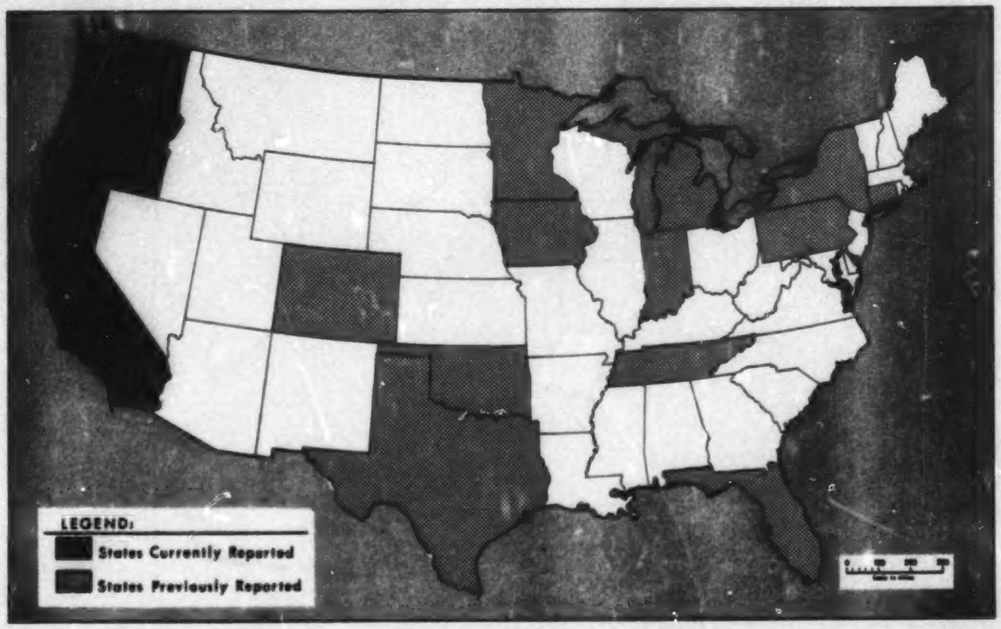

Figure 1. Reported State milk programs

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1. California Milk Network
October–December 1967

Division of Environmental Sanitation
State of California
Department of Public Health

Surveillance of specific radionuclides in milk is one phase of the California Department of Health program on radiation control. This milk monitoring function is conducted by the Department's Bureau of Radiological Health at 10 major milksheds (figure 2).

In January 1960, the eight original sampling locations were chosen by the State Department of Agriculture so as to be representative of milk consumed by a high percentage of the State's population. The Del Norte and Mendocino milksheds were added to the program in March 1962 and since that time, weekly, biweekly or monthly sampling of pasteurized milk has been conducted in 10 milkshed areas of the State. A description of the various California milksheds was presented earlier by Heslep and Cornish (*1*).

Strontium–89 and strontium–90 concentrations are determined radiochemically. Potassium–40, iodine–131, cesium–137, and barium–140 in whole fluid milk are determined by gamma-scintillation spectrometry. A detailed description of the analytical procedures was presented in an earlier report (*2*).

The monthly calcium, potassium, and radionuclide concentrations in California pasteurized milk are given in table 1 for the period of October to December 1967.

Network average strontium–90 and cesium–137 concentrations are presented graphically in figure 3.

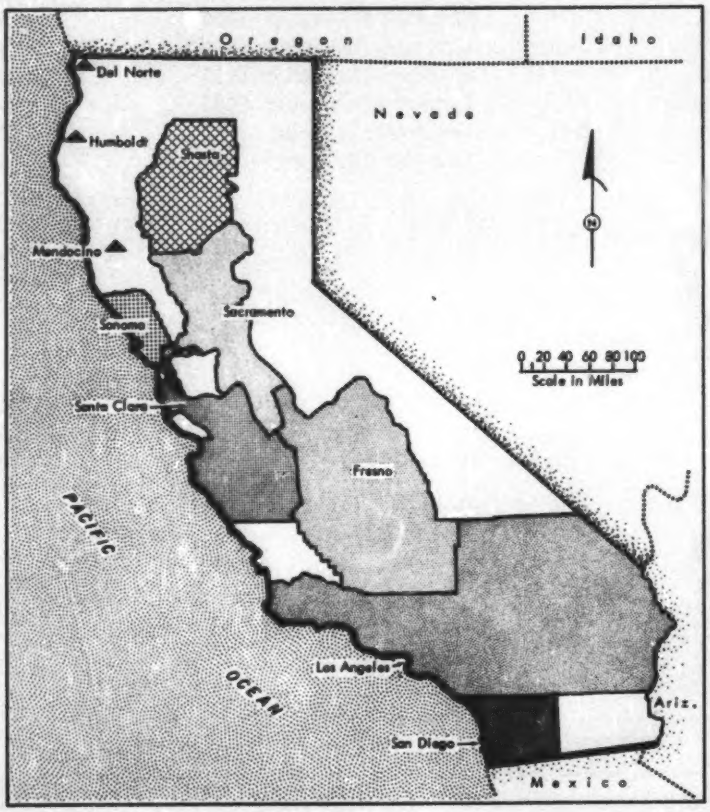
Oregon
Idaho
Nevada
Del Norte
Humboldt
Shasta
Mendocino
Sonoma
Sacramento
Santa Clara
Fresno
Los Angeles
San Diego
PACIFIC
OCEAN
Ariz.
Mexico
N
0 20 40 60 80 100
Scale in Miles

Figure 2. California milksheds

Table 1. Stable elements and radionuclide concentrations in California milk
October–December 1967

Sampling location	Calcium (g/liter)			Potassium (g/liter)			Strontium-89 (pCi/liter)			Strontium-90 (pCi/liter)		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
Del Norte	1.25	1.06	1.20	1.3	1.5	1.5	5	ND	ᵃ5	16	14	16
Fresno	1.20	NA	1.13	1.6	1.5	1.5	ND	NA	ND	ND	NA	2
Humboldt	1.20	1.15	1.00	1.4	1.4	1.4	ND	ND	ᵃ3	4	3	4
Los Angeles	1.07	1.13	1.02	1.6	1.6	1.7	ND	ND	ND	ND	ND	ND
Mendocino	1.21	1.16	1.18	1.6	1.7	1.6	ND	ND	ND	2	2	3
Sacramento	1.24	1.21	1.02	1.4	1.5	NA	4	ND	ND	ND	3	3
San Diego	1.13	1.12	1.15	1.5	1.5	1.5	ᵃ4	ND	ND	ND	ND	ND
Santa Clara	1.11	1.27	1.10	1.5	1.5	1.5	5	ND	ND	ND	ND	ND
Shasta	1.14	1.15	1.20	1.4	1.6	1.6	ND	ND	ND	2	2	3
Sonoma	1.17	1.28	1.14	1.4	1.6	1.6	ND	ND	ND	3	3	3

Sampling location	Cesium-137 (pCi/liter)			Iodine-131 (pCi/liter)			Barium-140 (pCi/liter)		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
Del Norte	20	13	50	ND	ND	22	ND	ND	15
Fresno	7	ND	11	ND	ND	ND	ND	ND	ND
Humboldt	ᵃ7	11	9	ND	ND	ND	ND	ND	ND
Los Angeles	10	13	ND	ND	ND	ND	ND	ND	ND
Mendocino	ND	ᵃ9	ND	ND	ND	ND	ND	ND	ND
Sacramento	10	11	NA	ND	ND	NA	ND	ND	NA
San Diego	ND	ND	ND	ND	ND	ND	ND	ND	ND
Santa Clara	ND	13	13	ND	ND	ND	ND	ND	ND
Shasta	9	10	12	ND	ND	ND	ND	ND	ND
Sonoma	13	ᵃ9	11	ND	ND	ND	ND	ND	ND

[a] When the counting rate of the sample is not equal to at least twice the 0.95 error, the value reported is the best available estimate, but is not statistically significant.
NA, no analysis performed.
NS, no sample collected.
ND, nondetectable.
Minimum detectable levels:
Strontium-89—2.5 pCi/liter
Strontium-90—1.5 pCi/liter
Iodine-131—7 pCi/liter
Cesium-137—7 pCi/liter
Barium-140—7 pCi/liter

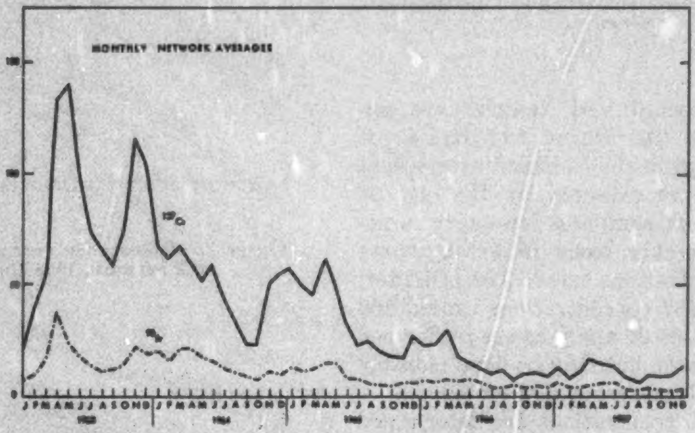

Figure 3. Radionuclide concentrations in California milk
1964–December 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	December 1967
July–September 1967	March 1968

2. Oregon Milk Network
October–December 1967

Division of Sanitation and Engineering
Oregon State Board of Health

The Oregon State Board of Health has monitored radionuclide concentrations in milk since March 1962. As part of this program routine milk samples are collected at seven major production areas (figure 4), which supply 90 percent of the milk distributed in Oregon.

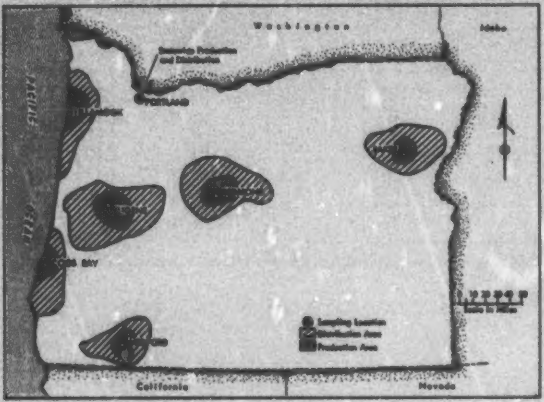

Figure 4. Oregon milk production and distribution areas

Currently, pasteurized milk samples are collected monthly by the Oregon Department of Agriculture, except in the Portland area where weekly samples are collected by the city of Portland. The milk sampling frequency is accelerated to a weekly basis in areas where iodine–131 concentrations exceed 100 pCi/liter, or when cesium–137 concentrations exceed 500 pCi/liter. Strontium–90 analyses are performed on a bimonthly basis, but may be done monthly when significant increases are observed.

Strontium–90 concentrations are determined using an ion-exchange analytical procedure (*3*). Iodine–131, cesium–137, and barium–140 concentrations are determined by gamma scintillation spectrometry (*4*).

Table 2 gives the strontium–90 and cesium–137 concentrations in pasteurized milk from October through December 1967. These data are presented graphically in figure 5. Iodine–131 and barium–140 concentrations remained below minimum detectable levels of 15 pCi/liter for all samples which were collected in October through December 1967.

Table 2. Radionuclide concentrations in Oregon pasteurized milk, October–December 1967

Location	Sampling frequency	Strontium–90 (pCi/liter)			Cesium–137 (pCi/liter)		
		Oct	Nov	Dec	Oct	Nov	Dec
Baker	M	NA	9	NA	NA	16	<15
Coos Bay	M	NA	9	NA	NA	22	<15
Eugene	M	NA	4	NA	NA	<15	<15
Medford	M	NA	6	NA	NA	<15	20
Portland composite	W	NA	4	NA	<15	16	17
Portland local	W	NA	NA	NA	NA	17	16
Redmond	M	NA	4	NA	NA	16	18
Tillamook	M	NA	NA	NA	NA	<15	NS

Key to symbols: M, sampled monthly.
W, sampled weekly.
NA, no analysis.
NS, no sample.

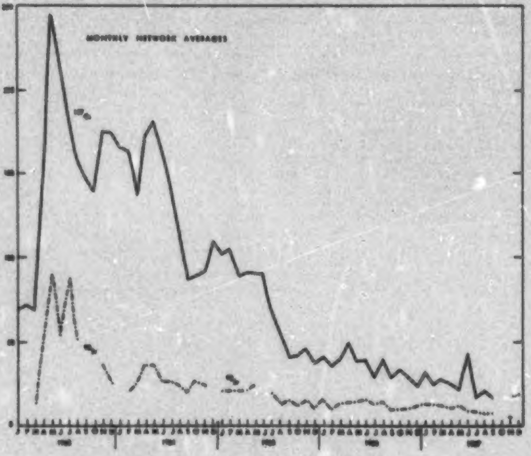

Figure 5. Radionuclide concentrations in Oregon milk network, 1962–December 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	December 1967
July–September 1967	March 1968

3. Washington Milk Network
October–December 1967

Air Quality and Radiation Control Section
State of Washington Department of Health

The Washington State Department of Health initiated a surveillance program for radioactivity in raw milk in December 1962. The collection points shown in figure 6 were selected to provide samples representative of varying climatological conditions within the State's two major milksheds. In addition to the eight milk sampling locations in Washington, milk is sampled from Northwest Idaho (Sandpoint), as this area forms a part of the Spokane milkshed. Details of the sampling procedures were presented in an earlier report (*5*).

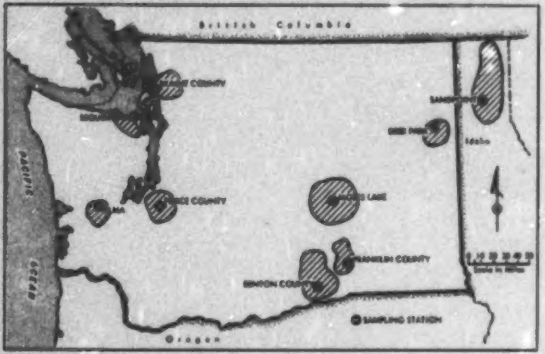

Figure 6. Washington milksheds and sampling locations

Selected samples are radiochemically analyzed for strontium-90. Potassium-40, iodine-131, cesium-137, and barium-140 concentrations are determined by gamma scintillation spectrometry. Details of the analytical procedures were presented earlier (*5*).

Table 3 presents the monthly potassium and radionuclide concentrations in Washington raw milk for October through December 1967. Samples collected during October through December 1967 contained less than 10 pCi/liter of iodine-131. Barium-140 results remained below 15 pCi/liter for all samples collected during this period. Monthly average strontium-90 and cesium-137 concentrations are presented graphically in figure 7 to display general trends.

Table 3. Stable element and radionuclide concentrations in Washington raw milk, October–December 1967

Sampling location	Potassium (g/liter)			Strontium-90 (pCi/liter)			Cesium-137 (pCi/liter)		
	Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
Benton County	NS	1.5	NS	NS	<1	NS	NS	<15	NS
Deer Park	1.4	1.5	1.5	5	4	3	<15	<15	<15
Elma	1.5	1.5	1.6	4	3	3	<15	25	24
Franklin County	1.5	NS	1.5	1	NS	2	<15	NS	<15
Moses Lake	1.5	1.5	1.5	3	<1	3	<15	<15	<15
Pierce County	1.6	1.5	1.5	2	3	2	<15	<15	<15
Sandpoint	1.6	1.4	1.5	9	4	9	25	23	17
Sequim	1.5	1.6	1.5	4	2	1	15	<15	<15
Skagit County	1.5	1.5	1.5	3	4	6	18	16	21

NS, no sample collected.

During this reporting period, three samples were collected (one from Benton County and two from Franklin County) and analyzed for zinc-65. In all three cases, zinc-65 levels were less than 26 pCi/liter. Milk samples produced in areas using Columbia River water for irrigation have periodically been found to contain this radionuclide.

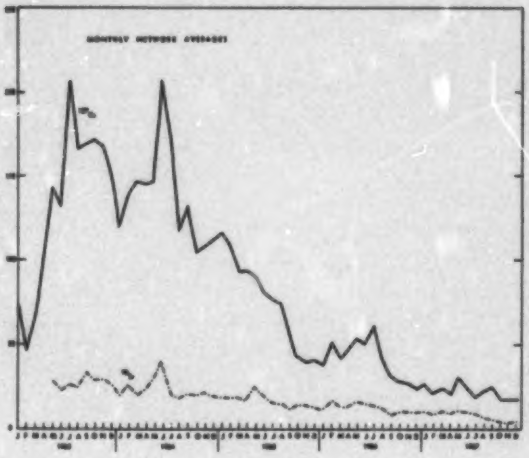

Figure 7. Radionuclide concentrations in Washington milk, 1963–December 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
April–June 1967	December 1967
July–September 1967	March 1967

REFERENCES

(1) HESLEP, J. M. and A. C. CORNISH. California milk network and milkshed comparisons, April–June 1963. Radiol Health Data 4:596–600 (December 1963).

(2) STATE OF CALIFORNIA DEPARTMENT OF PUBLIC HEALTH. California milk network, 1960–June 1962. Radiol Health Data 4:90–92 (February 1963).

(3) PORTER, C. R., M. W. CARTER, B. KAHN, and E. W. PEPPER. Rapid Field Method for the Collection of Radionuclides from Milk. Proceedings of the First International Congress of the International Radiation Protection Association held in Rome, Italy, September 5–10, 1966 (in press).

(4) OREGON STATE BOARD OF HEALTH, DIVISION OF SANITATION AND ENGINEERING. Oregon milk network, April–June 1965. Radiol Health Data 6:683–684 (December 1965).

(5) STATE OF WASHINGTON DEPARTMENT OF HEALTH, AIR AND RADIATION CONTROL SECTION. Washington milk network, January–June 1965. Radiol Health Data 6:619–621 (November 1965).

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Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Periodically, results from the United Kingdom Diet Survey, conducted by the United Kingdom Agricultural Research Council Radiobiological Laboratory, are presented for comparison with data observed in the United States. Programs most recently reported in *Radiological Health Data and Reports* and not covered in this issue are as follows.

Program	Period reported	Last presented
California Diet Study	July–December 1967	May 1968
Connecticut Standard Diet	January–June 1967	November 1967
Institutional Diet, PHS	July–September 1967	April 1968

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1. Strontium-90 in Tri-City Diets April–December 1967[1]

Health and Safety Laboratory
U.S. Atomic Energy Commission

Since March 1960, the Health and Safety Laboratory, through its quarterly diet study, has made estimates of the strontium-90 content of the average diet of individuals living in New York City, San Francisco, and Chicago.

Selected foods representing 18 food categories are purchased at each of these 3 cities every 3 months on a staggered basis (*i.e.*, New York City, May, August and November 1967; San Francisco, June, September, and December 1967; and Chicago, April, July, and October 1967) and are analyzed for strontium-90. Consumption figures used are based upon data from the Department of Agriculture (*1*). Some food types are assumed to be representative of larger food categories, such as liquid milk for dairy products in general.

The consumption data are based on a weight-as-purchased basis. Before the food samples for the Tri-City Diet Study are ashed for radiochemical analysis, they are prepared to a certain degree as if for actual consumption. For example, fruits are peeled, eggs are shelled, and poultry is boned. Therefore, concentrations of radioactivity in foods as reported in the Tri-City Diet Study are based on the trimmed weight. No correction is made for the waste.

After two samplings at each city, it was found that the calcuim content of most food categories did not vary among cities, nor did it vary significantly with time. Calcium analyses of dietary components were performed for the third time recently, and further confirmed this result (*2*). Calcium analyses were therefore discontinued and the average calcium content of foods was computed and used to estimate the average annual intake of this material. Details of the sampling system and a discussion of the results obtained have been summarized (*3*).

Results of the April–June samplings are presented in table 1; July–September in table 2, and October–December 1967 in table 3. The variation with time of the daily intake of strontium-90 in the three cities is plotted in

Table 1. Average dietary consumption and strontium-90 intake in Tri-City diet April–June 1967

Food category	Diet (kg/yr)	Calcium (g/yr)	Chicago-April 1967		New York-May 1967		San Francisco-June 1967	
			(pCi/kg)	(pCi/yr)	(pCi/kg)	(pCi/yr)	(pCi/kg)	(pCi/yr)
Milk	221	234.5	9.5	2,100	10.4	2,298	4.4	972
Fresh fruit	68	12.9	2.6	177	11.8	802	2.6	177
Fresh vegetables	43	15.3	13.1	563	33.7	1,449	4.2	181
Root vegetables	17	6.3	9.0	153	19.1	325	7.6	129
Potatoes	45	4.9	6.6	297	9.8	441	1.7	77
Macaroni	3	0.6	8.1	24	3.9	12	6.5	20
Rice	3	1.0	1.8	5	1.9	6	2.4	7
Fruit juices	19	1.7	4.8	91	7.1	135	4.4	84
Canned vegetables	20	4.2	15.4	308	6.8	136	4.7	94
Canned fruit	26	1.3	2.1	55	1.5	39	1.8	47
Dried beans	3	3.1	31.7	9	8.7	26	30.7	92
Flour	43	8.6	8.5	366	8.8	378	4.5	194
Bakery products	37	30.3	3.6	133	8.2	303	12.0	444
Whole grain products	11	10.1	12.5	138	19.6	216	21.3	234
Meat, fish, poultry, eggs	115	28.2		ᵃ233		ᵃ346		ᵃ145
Annual intake		363		4,652		6,912		2,897
Daily intake (pCi/day)				12.7		18.9		7.9
pCi strontium-90/g Ca				12		18		7.6

ᵃ Estimated as 5 percent of total intake.

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[1] Data from Fallout Program Quarterly Summary Report, HASL-193. Available from the Clearinghouse for Federal Scientific & Technical Information, CFSTI, 5285 Port Royal Road, Springfield, Va. 22151.

Table 2. Average dietary consumption and strontium-90 intake in Tri-City diet
July–September 1967

Food category	Diet (kg/yr)	Calcium (g/yr)	Chicago-July 1967		New York-August 1967		San Francisco-September 1967	
			(pCi/kg)	(pCi/yr)	(pCi/kg)	(pCi/yr)	(pCi/kg)	(pCi/yr)
Milk	221	284.5	6.2	1,370	12.9	2,851	2.1	464
Fresh fruit	68	12.9	4.6	313	5.3	360	1.9	128
Fresh vegetables	43	15.3	----------	ᵃ 328	15.7	675	2.8	120
Root vegetables	17	6.3	5.1	87	30.0	510	6.7	114
Potatoes	45	4.9	----------	ᵃ 455	12.1	545	2.3	104
Macaroni	3	0.6	5.0	15	6.4	19	5.0	15
Rice	3	1.0	2.9	9	1.8	5	1.9	6
Fruit juices	19	1.7	3.8	72	6.0	114	3.0	57
Canned vegetables	20	4.2	7.4	148	9.3	186	5.2	104
Canned fruit	26	1.3	1.2	31	1.5	[illegible]	0.6	16
Dried beans	3	3.1	13.7	41	62.5	188	10.4	31
Flour	43	8.6	13.0	559	11.4	490	3.0	129
Bakery products	37	30.3	16.1	596	----------	ᵃ 220	3.5	130
Whole grain products	11	10.1	39.0	429	----------	ᵃ 169	8.8	97
Meat, fish, poultry, eggs	115	35.8	----------	ᵇ 246	----------	ᵇ 341	----------	ᵇ 79
Annual intake		383		4,912		6,822		1,595
Daily intake (pCi/day)				13.5		18.7		4.4
pCi strontium-90/g Ca				13		18		4.2

ᵃ Estimated from other sampling dates.

ᵇ Estimated as 5 percent of total intake.

Table 3. Average dietary consumption and strontium-90 intake in Tri-City diet
October–December 1967

Food category	Diet (kg/yr)	Calcium (g/yr)	Chicago-October 1967		New York-November		San Francisco-December	
			(pCi/kg)	(pCi/yr)	(pCi/kg)	(pCi/yr)	(pCi/kg)	(pCi/yr)
Milk	221	284.5	6.0	1,326	8.3	1,834	1.6	354
Fresh fruit	68	12.9	3.7	252	13.7	932	1.2	82
Fresh vegetables	43	15.3	6.1	262	38.5	1,656	4.5	194
Root vegetables	17	6.3	8.1	138	9.8	167	2.1	36
Potatoes	45	4.9	----------	ᵃ 455	9.3	419	2.7	121
Macaroni	3	0.6	5.1	15	5.1	15	3.0	9
Rice	3	1.0	1.9	6	3.7	11	1.5	5
Fruit juices	19	1.7	3.2	61	3.2	61	1.6	30
Canned vegetables	20	4.2	13.2	264	10.1	202	2.4	48
Canned fruit	26	1.3	2.1	55	1.0	26	1.0	26
Dried beans	3	3.1	12.5	38	28.6	86	16.9	51
Flour	43	8.6	8.8	378	14.0	602	3.1	133
Bakery products	37	30.2	9.1	337	5.2	192	2.8	104
Whole grain products	11	10.1	14.4	158	15.6	172	3.6	40
Meat, fish, poultry, eggs	115	35.8	----------	ᵇ 197	----------	ᵇ 336	----------	ᵇ 65
Annual intake		383		3,942		6,711		1,309
Daily intake (pCi/day)				10.8		18.4		3.6
pCi strontium-90/g Ca				10		18		3.4

ᵃ Estimated from other sampling dates.
ᵇ Estimated as 5 percent of total intake.

figure 1. A discussion of cesium-137 intakes as reflected in the Tri-City Diet Study has been presented previously (4).

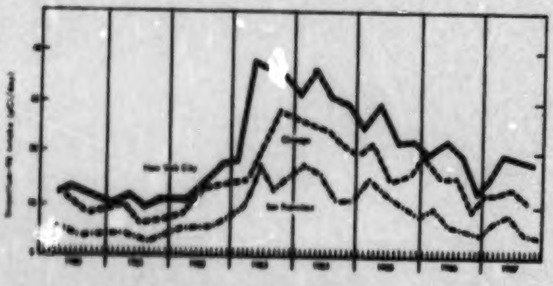

Figure 1. Daily intake of strontium-90 in Tri-City diet March 1960–December 1967

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
May–July 1966	June 1967
August–December 1966	September 1967
January–March 1967	March 1968

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REFERENCES

(*1*) U.S. DEPARTMENT OF AGRICULTURE. Food consumption of households in the United States, household food consumption survey, Report No. 1 (1965). Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (December 1966).

(*2*) U.S. ATOMIC ENERGY COMMISSION. Fallout program quarterly summary reports HASL–144: 231–297. Office of Technical Services, Department of Commerce, Washington, D.C. 20230 (April 1, 1964). Summarized in Radiol Health Data 5:285–288 (June 1964).

(*3*) RIVERA, J., and J. H. HARLEY. HASL contributions to the study of fallout in food chains, HASL–147. Office of Technical Services, Department of Commerce, Washington, D.C. 20230 (July 1, 1964).

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SECTION II. WATER

The Public Health Service, the Federal Water Pollution Control Administration and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*), set the limits for approval of a drinking water supply containing radium-226 and strontium-90 as 3 pCi/liter and 10 pCi/liter, respectively. Limits may be set higher if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities recently reported in *Radiological Health Data and Reports* are listed below.

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[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Last presented
Colorado River Basin	1965–1966	May 1968
Coast Guard	January–December 1966	November 1967
Minnesota Municipal	January–June 1967	January 1968
New York Surface	January–May 1967	January 1968
Washington Surface	July 1965–June 1966	August 1967

REFERENCES

(*1*) U.S. PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962, PHS Publication No. 956. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

(*2*) FEDERAL RADIATION COUNCIL. Radiation Protection Guidance for Federal Agencies. Memorandum for the President, September 1961. Reprint from the Federal Register of September 26, 1961.

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

Gross Radioactivity in Surface Waters of the United States, December 1967

Division of Pollution Surveillance, Federal
Water Pollution Control Administration
Department of Interior

The monitoring of levels of radioactivity in surface waters of the United States was begun in 1957 as part of the Federal Water Pollution Control Administration's Water Pollution Surveillance System. Table 1 presents the current preliminary results of the alpha and beta radioanalyses. The radioactivity associated with dissolved solids provides a rough indication of the levels which would occur in treated water, since nearly all suspended matter is removed by treatment processes. Strontium-90 results are reported semiannually. The stations on each river are arranged in the table according to their distance from the headwaters. Figure 1 indicates the average total beta radioactivity in suspended-plus-dissolved solids in raw water collected at each station. A description of the sampling and analytical procedures was published in the August 1967 issue of *Radiological Health Data and Reports.*

Complete data and exact sampling locations for 1958 through 1963 are published in annual compilations (*1–6*). Data for subsequent years are available on request.

Special note is taken when the alpha radioactivity is 15 pCi/liter or greater or when the beta radioactivity is 150 pCi/liter or greater. These arbitrary levels provide a basis for the selection of certain data for comment. They reflect no public health significance as the Public Health Service drinking water standards have already provided the basis for this assess-

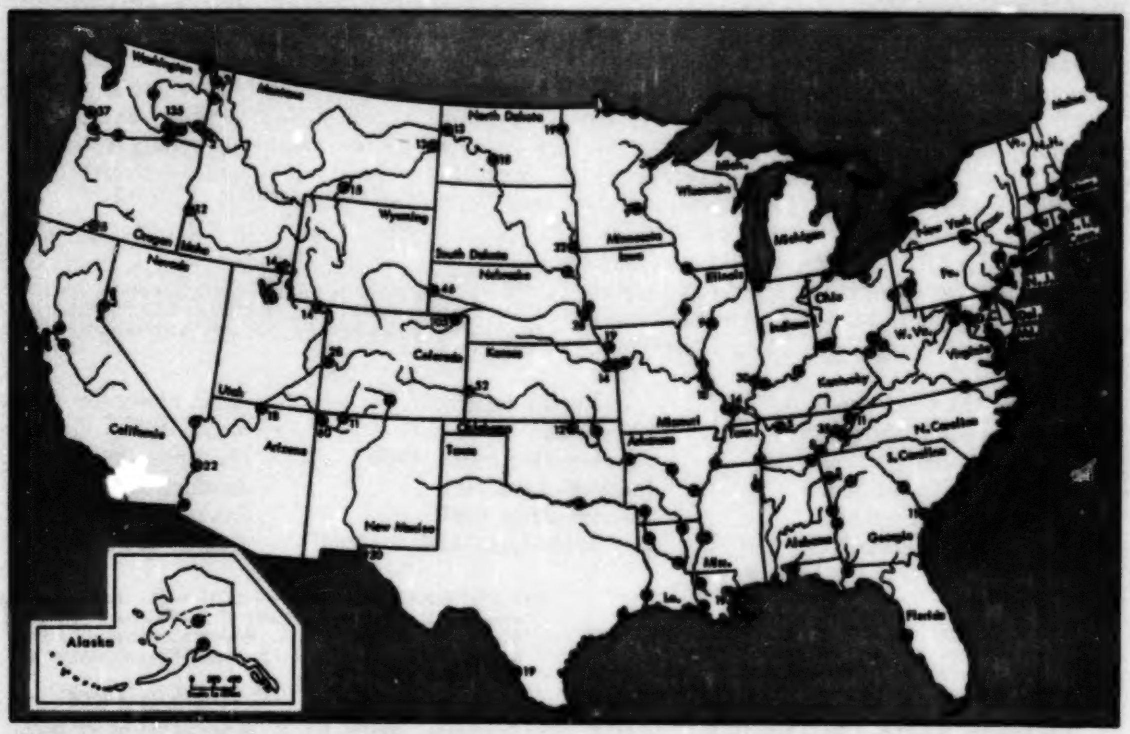
Washington
Montana
North Dakota
Oregon
Idaho
Wyoming
South Dakota
Nebraska
Nevada
Utah
Colorado
Kansas
California
Arizona
New Mexico
Oklahoma
Texas
Minnesota
Iowa
Wisconsin
Michigan
Illinois
Indiana
Ohio
Missouri
Kentucky
Arkansas
Miss.
La.
Alabama
Georgia
Florida
S. Carolina
N. Carolina
Virginia
W. Va.
Pa.
New York
Maine
Alaska

Figure 1. Sampling locations and associated total beta radioactivity (pCi/liter) in surface waters, December 1967

Table 1. Radioactivity in raw surface waters, December 1967

Station	Average alpha radioactivity (pCi/liter)			Average beta radioactivity (pCi/liter)		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Animas River:						
Cedar Hill, N. Mex.	0	<1	<1	3	8	11
Arkansas River:						
Coolidge, Kans.	<1	31	31	5	47	52
Ponca City, Okla.	0	5	5	0	13	13
Bear River:						
Preston, Idaho	0	3	3	1	13	14
Big Horn River:						
Hardin, Mont.	0	6	6	1	14	15
Big Sioux River:						
Sioux Falls, S. Dak.	0	3	3	2	30	32
Clearwater River:						
Lewiston, Idaho	<1	0	<1	1	1	2
Clinch River:						
Clinton, Tenn.	2	0	2	7	4	11
Kingston, Tenn. ᵃ	0	0	0	5	30	35
Colorado River:						
Loma, Colo.	3	4	7	14	14	28
Page, Ariz.	0	4	4	0	18	18
Parker Dam, Calif.-Ariz.	0	5	5	1	21	22
Columbia River:						
Pasco, Wash ᵃ	0	<1	<1	10	125	135
Clatskanie, Ore.	0	0	0	9	28	37
Connecticut River:						
Enfield Dam, Conn.	0	0	0	1	3	4
Coosa River:						
Rome, Ga.	1	0	1	3	2	5
Cumberland River:						
Cheatham Lock, Tenn.	0	0	0	1	4	5
Delaware River:						
Philadelphia, Pa.	0	0	0	0	4	4
Great Lakes:						
Duluth, Minn.	0	1	1	1	2	3
Green River:						
Dutch John, Utah	0	2	2	0	14	14
Hudson River:						
Poughkeepsie, N. Y.	0	0	0	1	5	6
Illinois River:						
Peoria, Ill.	0	1	1	1	8	9
Kansas River:						
DeSoto, Kans.	0	2	2	1	13	14
Klamath River:						
Keno, Ore.	0	0	0	1	4	5
Mississippi River:						
St. Paul, Minn.	0	1	1	0	9	9
E. St. Louis, Ill.	3	1	4	10	8	18
New Orleans, La.	2	1	3	11	8	19
Missouri River:						
Williston, N. Dak.	1	6	7	0	13	13
Bismarck, N. Dak.	1	2	3	5	13	18
St. Joseph, Mo.	1	3	4	3	16	19
North Platte River:						
Henry, Nebr.	1	25	26	5	41	46
Ohio River:						
Cairo, Ill.	4	0	4	8	6	14
Pend Oreille River:						
Albeni Falls Dam, Idaho	0	<1	<1	<1	3	3
Platte River:						
Plattsmouth, Nebr.	2	4	6	10	16	26
Potomac River:						
Washington, D.C.	1	1	2	3	4	7
Rainy River:						
Baudette, Minn.	0	0	0	0	7	7
Red River, North:						
Grand Forks, N. Dak.	0	0	0	1	18	19
Rio Grande:						
El Paso, Tex.	1	10	11	1	19	20
Laredo, Tex.	2	3	5	9	10	19
San Juan River:						
Shiprock, N. Mex.	13	3	16	40	20	60
Savannah River:						
Port Wentworth, Ga. ᵃ	0	0	0	3	8	11
Snake River:						
Payette, Idaho	0	3	3	1	11	12
South Platte River:						
Julesburg, Colo.	6	46	52	19	86	105
Tennessee River:						
Chattanooga, Tenn.	1	0	1	4	4	8
Wabash River:						
New Harmony, Ind.	7	0	7	23	7	30
Yellowstone River:						
Sidney, Mont.	0	8	8	2	11	13
Maximum	13	46	52	40	125	135
Minimum	0	0	0	0	1	2

ᵃ Gross beta radioactivity at this station may not be directly comparable to gross beta radioactivity at other stations because of the possible contribution of radionuclides from an upstream nuclear facility in addition to the contribution from fallout and naturally occurring radionuclides.

ment. Changes from or toward these arbitrary levels are also noted in terms of changes in radioactivity per unit weight of solids. A discussion of gross radioactivity per gram of solids for all stations of the Water Pollution Surveillance System for 1961 through 1965 has been presented (*7*). Comments are made only on monthly average values. Occasional high values from single weekly samples may be absorbed into a relatively low average. When these values are significantly high, comment will be made.

During November and December 1967, the following stations showed values in excess of 15 pCi/liter on alpha radioactivity for dissolved solids:

Arkansas River; Coolidge, Kans.
North Platte River; Henry, Nebr.
South Platte River; Julesburg, Colo.

During December, Pasco, Wash., on the Columbia River showed a decrease in the value to less than 150 pCi/liter on beta radioactivity for dissolved solids.

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(*2*) *Ibid.*, 1959 Edition.

(*3*) *Ibid.*, 1960 Edition.

(*4*) *Ibid.*, 1961 Edition.

(*5*) *Ibid.*, 1962 Edition.

(*6*) PUBLIC HEALTH SERVICE, DIVISION OF WATER SUPPLY AND POLLUTION CONTROL. Water pollution surveillance system, annual compilation of data, PHS Publication No. 663 (Revised), 1963 Edition. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(*7*) JULIAN, E. C. Gross radioactivity of the solids in selected surface waters of the United States, 1961–1965. Radiol Health Data Rep 9:1–15 (January 1968).

Radioactivity In California Waters, January–June 1967[1]

Bureau of Radiological Health,
State of California, Department of Public Health

Gross beta radioactivity in California domestic waters is monitored by the State of California's Bureau of Radiological Health. The importance of this program in the State's environmental surveillance activities stems from the fact that most of California's domestic water supplies are of surface origin.

Radioactivity in such water supplies consists of the natural radioactivity in surface streams, radioactivity added by the discharge of sewage or by industrial waste effluents, and radioactivity from fallout, particularly fallout into open terminal or distribution reservoirs. Present efforts consist of sampling raw and treated surface waters and well waters. It should be noted that except for large metropolitan water supplies, raw water sampling is being phased out and treated water sampling being substituted or continued. This procedural change is predicated upon sampling water at the point of consumption.

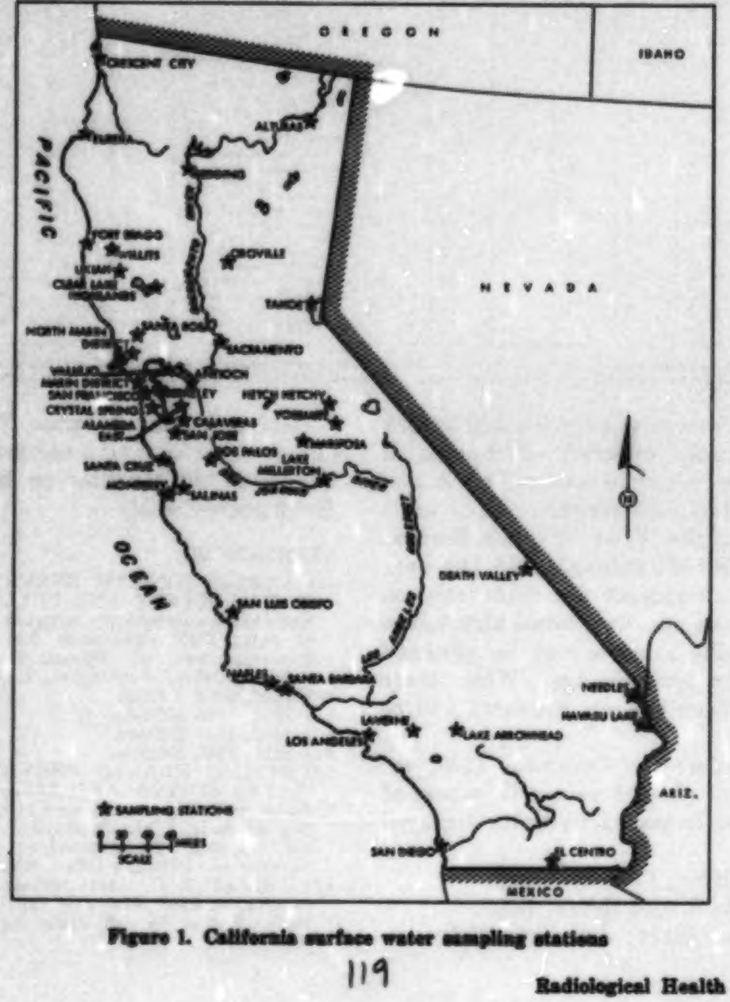
OREGON
IDAHO
CRESCENT CITY
ALTURAS
EUREKA
REDDING
PACIFIC
OCEAN
FORT BRAGG
WILLITS
UKIAH
OROVILLE
CLEAR LAKE HIGHLANDS
TAHOE
NEVADA
NORTH MARIN DISTRICT
SANTA ROSA
SACRAMENTO
VALLEJO
MARIN DISTRICT
SAN FRANCISCO
ANTIOCH
HETCH HETCHY
YOSEMITE
CRYSTAL SPRINGS
CALAVERAS
ALAMEDA EAST
SAN JOSE
MARIPOSA
DOS PALOS
LAKE MILLERTON
SANTA CRUZ
MONTEREY
SALINAS
N
DEATH VALLEY
SAN LUIS OBISPO
NAPLES
SANTA BARBARA
NEEDLES
HAVASU LAKE
LA VERNE
LAKE ARROWHEAD
LOS ANGELES
ARIZ.
SAMPLING STATIONS
0 20 40 60 MILES
SCALE
SAN DIEGO
EL CENTRO
MEXICO

Figure 1. California surface water sampling stations

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[1] Data from July and October 1967 issues of Radiological Health News, State of California Department of Public Health, Bureau of Radiological Health, 2151 Berkeley Way, Berkeley, Calif. 94704.

Most of the supplies sampled have, as a source, raw surface waters (figure 1), although a few wells, along with some water supplies that use infiltration galleries, are also sampled.

Monitoring of domestic water supplies is on a continuing basis, since it has not been possible to forecast levels of radioactivity in these supplies based upon levels in rain, snow, or surface streams. Under the present sampling schedule, monthly 500 ml samples are collected and the total solids analyzed for alpha and beta radioactivity. In addition, 3-liter samples are

Table 1. Gross beta radioactivity in California domestic waters, January–June 1967

Sampling station	Quality	Concentration (pCi/liter)					
		January	February	March	April	May	June
Alturas	Well	60	[a]10	[a]12	[a]17	[a]21	NS
Antioch	Treated	ND	[a]12	[a]5	[a]2	ND	ND
Berkeley	Treated	ND	[a]3	ND	[a]2	[a]1	[a]4
Clearlake Highlands	Treated	[a]3	[a]2	ND	ND	[a]3	ND
Crescent City	Well	[a]11	[a]4	[a]10	79	[a]11	[a]2
Death Valley	Treated	[a]13	[a]16	41	[a]13	[a]15	[a]14
Dos Palos	Treated	[a]17	[a]4	[a]27	[a]23	[a]6	NS
Eureka	Raw	[a]14	[a]12	ND	[a]3	[a]11	[a]5
	Treated	ND	[a]5	10	[a]6	ND	ND
Fort Bragg	Treated	NS	NS	NS	NS	[a]14	ND
Lake Arrowhead	Treated	[a]15	[a]8	[a]3	[a]8	NS	NS
Lake Millerton	Raw	[a]19	[a]9	[a]15	[a]4	[a]6	[a]7
Los Angeles Laboratory	Raw	[a]17	[a]12	NS	[a]19	NS	NS
Marin Municipal Water District	Treated	ND	[a]4	[a]6	ND	[a]3	[a]6
Mariposa	Treated	NS	[a]5	NS	[a]18	ND	NS
Metropolitan Water District of Southern California:							
Lake Havasu	Raw	[a]11	ND	[a]26	[a]21	[a]15	NS
Weymouth Plant	Treated	[a]24	70	[a]24	67	[a]7	[a]34
Monterey	Treated	[a]15	[a]16	ND	NS	[a]4	[a]11
Napa	Treated	5	ND	ND	[a]18	ND	[a]13
Needles	Well	[a]27	[a]24	[a]19	NS	[a]9	[a]9
North Marin Water District	Treated	[a]9	NS	[a]5	[a]1	[a]3	[a]3
	Raw	[a]4	[a]12	[a]9	[a]13	[a]14	[a]8
	Sludge [b]	133	NS	118	[a]30	[a]40	ND
Oroville:							
Wyandotte Irrigation District	Treated	[a]6	[a]10	[a]15	[a]17	ND	[a]6
Pleasanton	Well	ND	[a]13	[a]2	ND	ND	[a]2
Redding	Treated	ND	[a]9	ND	ND	ND	ND
Sacramento:							
American River	Treated	NS	[a]5	NS	[a]13	[a]5	[a]1
Sacramento River	Treated	NS	[a]14	NS	5	[a]3	ND
San Diego	Raw	[a]12	[a]9	33	[a]15	[a]24	ND
	Treated	[a]7	[a]23	[a]11	[a]1	[a]19	[a]15
San Francisco:							
Water Department	Raw	[a]13	54	ND	[a]3	[a]11	ND
Alameda, East	Raw	[a]5	[a]4	NS	[a]8	[a]5	NS
Brightside Weir	Raw	ND	[a]3	[a]9	[a]11	75	NS
Calaveras Reservoir	Raw	ND	[a]16	[a]6	[a]1	[a]15	NS
Crystal Springs	Raw	[a]11	[a]2	NS	ND	[a]14	NS
Hetch Hetchy	Raw	[a]13	[a]8	[a]23	[a]15	ND	[a]8
San Jose	Raw	ND	NS	ND	[a]6	[a]9	ND
Santa Barbara	Treated	ND	ND	ND	[a]11	ND	ND
Santa Cruz	Raw	NS	NS	NS	NS	NS	[a]6
	Treated	NS	NS	NS	NS	NS	[a]6
Santa Rosa	Raw	ND	ND	[a]5	[a]14	ND	ND
Scotia	Treated	NS	NS	[a]9	[a]3	[a]1	[a]7
Tahoe City	Raw	NS	[a]8	NS	[a]3	[a]3	[a]6
Ukiah	Well	[a]4	NS	NS	[a]15	ND	ND
Vallejo:							
Fleming Hill	Raw	[a]4	[a]11	[a]14	[a]4	[a]2	[a]4
	Treated	ND	[a]7	ND	[a]4	[a]13	[a]10
Swanzy Reservoir	Treated	[a]3	ND	ND	[a]12	[a]10	ND
Yosemite	Treated	[a]7	[a]8	ND	[a]5	[a]3	[a]6
Maximum		133	70	118	79	75	34
Minimum		2	2	2	1	1	1

[a] When the counting rate of the sample is not equal to at least twice the 0.95 error, the value reported is the best estimate, but is not statistically significant.

[b] Sludge reported in pCi/g (dry weight).

NS, no sample collected.

ND, no detectable radioactivity.

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collected monthly for approximately 6 months and composited for specific radionuclide analysis on a semiannual basis.

Analytical procedures

Radionuclide analyses of water are carried out in the State's Sanitation and Radiation Laboratory. Measurements of alpha and alpha-plus-beta radioactivities are made with a low-background windowless gas-flow proportional counter. Counting methods used follow those recommended by the U.S. Public Health Service (*1*).

Individual samples are evaporated to dryness and the residue ashed at 450°C. The ashed sample is dissolved and transferred to an aluminum planchet for beta-particle counting. Specific radionuclides are determined semiannually on composite samples. Gamma-ray emitting nuclides are determined by gamma-ray spectroscopy and radium and radiostrontium by chemical separation and counting.

Discussion

Table 1 shows the monthly average beta radioactivity in the suspended-plus-dissolved solids in surface water supplies in California

Table 2. Radionuclide concentrations in California surface water, 1966–1967

Sampling station and date	Concentration (pCi/liter)						
	Radium-226	Cerium-141-144	Cesium-137	Zirconium-niobium-95	Strontium-90	Strontium-89	Potassium-40
Antioch:							
August-December 1966	0.03	ND	ND	ND	1	ND	3
Berkeley:							
June-December 1966	[a]0.02	ND	ND	ND	1	ND	2
Death Valley							
July-December 1966	[a]0.03	[a]1	[a]1	[a]1	1	ND	15
Dos Palos:							
September 1966-March 1967	NA	ND	ND	ND	ND	[a]1	[a]2
Eureka:							
January-June 1965 [b]	0.04	[a]1	ND	ND	ND	[a]1	[a]1
June-December 1965 [b]	0.03	ND	[a]1	ND	ND	ND	ND
January-June 1966	[a]0.01	ND	ND	ND	ND	[a]1	[a]1
July-December 1966	[a]0.02	[a]1	ND	ND	ND	ND	ND
Lake Millerton:							
July-December 1966	[a]0.02	ND	ND	ND	1	ND	ND
November 1966-March 1967	[a]0.01	ND	ND	ND	1	ND	[a]2
Metropolitan Water District of Southern California:							
Weymouth Plant:							
July-December 1966	NA	ND	ND	ND	[a]1	ND	[a]4
Monterey:							
September 1966-February 1967	0.11	ND	ND	ND	ND	2	3
Napa:							
August-December 1966	NA	ND	ND	ND	[a]1	[a]1	[a]4
Needles:							
August-December 1966	[a]0.06	ND	ND	ND	ND	ND	7
North Marin Water District:							
July-December 1966	ND	ND	ND	ND	1	NA	[a]4
Oroville:							
December 1966-April 1967	NA	ND	ND	ND	ND	1	[a]1
Redding:							
July-December 1966	[a]0.01	ND	ND	ND	ND	ND	[a]1
San Diego:							
June-December 1966	[a]0.12	ND	ND	ND	2	ND	5
San Francisco:							
January-November 1966	[a]0.01	ND	ND	[a]2	NS	NS	[a]1
San Jose:							
July-December 1966	0.03	ND	ND	ND	ND	ND	[a]2
Santa Barbara:							
September 1966-February 1967	NA	ND	ND	ND	ND	ND	2
Santa Cruz:							
July-December 1966	NA	ND	ND	ND	NS	NS	[a]2
Santa Rosa:							
September 1966-February 1967	0.03	ND	ND	[a]1	ND	ND	[a]3
Tahoe City:							
July-December 1966	[a]0.01	ND	ND	[a]1	ND	ND	[a]1
Vallejo:							
July-December 1966	[a]0.02	ND	ND	ND	1	1	2
Willets:							
July 1966-January 1967	0.04	ND	1	1	ND	ND	3
Yosemite:							
November 1966-March 1967	[a]0.02	ND	ND	ND	1	ND	ND

Results for manganese-54 for all stations were nondetectable during this period except for a value of [a] 1 pCi/liter at Eureka for January-June 1965 and July-December 1965.

[a] When the counting rate of the sample is not equal to at least twice the 0.95 error, the value reported is the best available estimate but is not statistically significant.

[b] Data not previously reported.

NA, no analysis.

ND, no detectable radioactivity.

NS, no sample.

from January through June 1967. Following treatment, these waters are used for industrial and domestic purposes. Because alpha radioactivity in water has, in general, been undetectable or very slight, alpha radioactivity analyses are not presented. No increase in radioactivity level of surface water has been observed.

Table 2 shows specific radionuclide concentrations in California surface waters for 1965 through April 1967 by stations.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–June 1966	June 1967
July–December 1966	February 1968

REFERENCE

(*1*) PUBLIC HEALTH SERVICE, DIVISION OF RADIOLOGICAL HEALTH. Radionuclide analyses of environmental samples, R 59–6. Radiological Health Research Activities, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio 45226 (November 16, 1959).

Radiostrontium In Tap Water, July–December 1967[1]

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory has performed analyses for strontium–90 in tap water at New York City since August 1954. Samples of tap water are collected daily so that by the end of the month a composite of at least 100 liters is available for analysis. Cesium–137 determinations were begun in January 1964. The analytical methods used at the laboratory are given in the Health and Safety Laboratory Manual of Standard Procedures (*1*).

Strontium–90 concentration and cesium–137/strontium–90 ratios in New York City tap water for July through December 1967 are presented in table 1. These results appear graphically in figure 1.

A decreasing trend has been observed in the strontium–90 concentrations since the July 1963 peak. The maximum strontium–90 concentrations observed are below the acceptable limit as set forth in the interstate carrier drinking water standards (*2*).

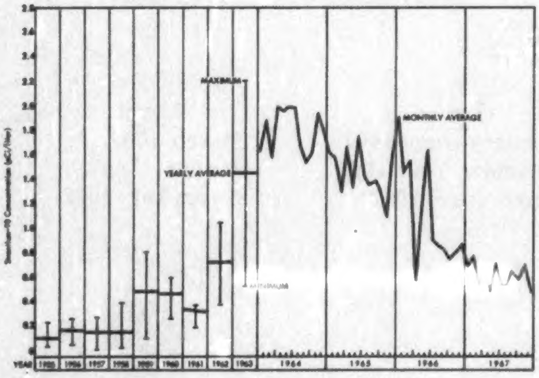

Figure 1. Strontium–90 concentrations in New York City tap water, 1955–December 1967

Table 1. Radiostrontium in New York City tap water July–December 1967

Date 1967	Strontium-90 ᵃ (pCi/liter)	Cesium-137/ strontium-90
July	0.55	0.09
August	.55	.09
September	.61	.06
October	.58	.10
November	.68	.15
December	.45	.13

ᵃ Approximately 100 liters per sample.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–June 1967	April 1968

REFERENCES

(*1*) U.S. ATOMIC ENERGY COMMISSION. Manual of standard procedures 40:E–38–01–16. Health and Safety Laboratory, U.S. Atomic Energy Commission, 376 Hudson Street, New York 14, N.Y.

(*2*) FEDERAL REGISTER RULES AND REGULATIONS. Title 42–Public Health, Chapter 1, Public Health Service, Department of Health, Education and Welfare; Part 72, Interstate Quarantine, Subpart J, Drinking Water Standards 27:2154–2155. Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 (March 6, 1962).

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[1] Prepared from information appearing in Fallout Program Quarterly Summary Report, HASL–193. This report is available from the Clearinghouse for Federal Scientific and Technical Information, CFSTI, 5285 Port Royal Road, Springfield, Va. 22151.

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta-particle analysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the U.S. Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

An intercomparison of the above networks was performed by Lockhart and Patterson in 1962 and is summarized in the January 1964 issue of *Radiological Health Data*. In addition to those programs presented in this issue, the following programs were previously covered in *Radiological Health Data and Reports:*

Network	Period	Issue
HASL Fallout Network	January–June 1967	March 1968
HASL 80th Meridian Network	Calendar Year 1965	January 1967
Plutonium in Airborne Particulates	April–June 1967	November 1967

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1. Radiation Alert Network
February 1968

National Center for Radiological Health
U.S. Public Health Service

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 73 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection when most of the radon daughter products have decayed and at 29 hours after collection when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate National Center for Radiological Health officials by mail or telephone, depending on levels found. Compilation of the daily field estimates is reported elsewhere on a monthly basis (*1*). A detailed description of the sampling and analytical procedures was presented in the April 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique during February 1968. Time profiles of gross beta radioactivity in air for eight Radiation Alert Network stations are shown in figure 2.

All field estimates reported were within normal limits for the reporting station.

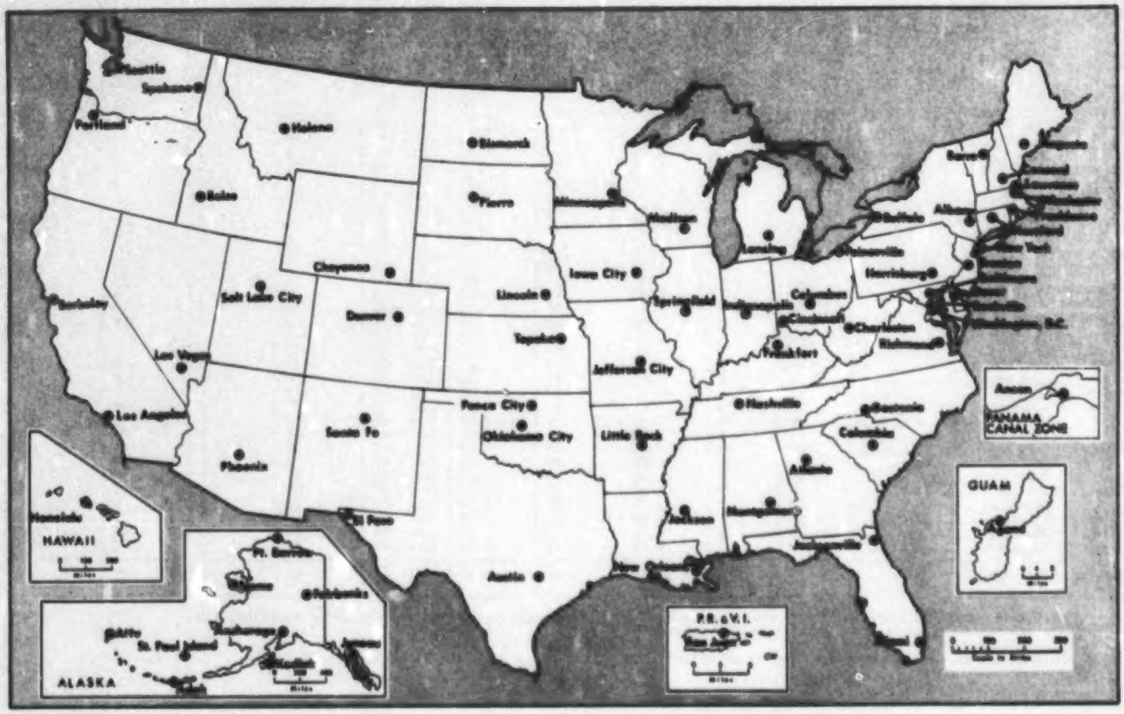
Seattle
Spokane
Portland
Helena
Bismarck
Boise
Pierre
Minneapolis
Madison
Lansing
Buffalo
Albany
Barre
Augusta
Concord
Providence
New York
Harrisburg
Washington, D.C.
Richmond
Charleston
Columbus
Cincinnati
Frankfort
Indianapolis
Springfield
Iowa City
Lincoln
Cheyenne
Salt Lake City
Denver
Topeka
Jefferson City
Berkeley
Las Vegas
Los Angeles
Ponca City
Oklahoma City
Santa Fe
Phoenix
Little Rock
Nashville
Gastonia
Columbia
Atlanta
Jackson
Montgomery
Jacksonville
New Orleans
Miami
El Paso
Austin
Honolulu
HAWAII
Miles
Pt. Barrow
Nome
Fairbanks
Anchorage
St. Paul Island
Kodiak
Juneau
Attu
Adak
ALASKA
Miles
P.R. & V.I.
San Juan
Miles
Ancon
PANAMA CANAL ZONE
GUAM
Agana
Miles
Scale in Miles

Figure 1. Radiation Alert Network sampling stations

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Table 1. Gross beta radioactivity in surface air and precipitation, February 1968

Station location		Number of samples		Air surveillance gross beta radioactivity (pCi/m³)			Last profile in RHD&R	Precipitation			
								Total depth (mm)	Field estimation of deposition		
		Air	Ppts	Maximum	Minimum	Average [a]			Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	20	3	6.83	0.73	2.03	Nov 67	46	0	0	
Alaska:	Adak	([b])					Apr 68	([c])			
	Anchorage	19	6	1.20	.00	.12	Dec 67	25	([d])	([d])	([d])
	Attu Island	([b])					May 68	([c])			
	Fairbanks	([b])					Jan 68	([c])			
	Juneau	18	11	.38	.00	.08	Feb 68	51	11	151	0
	Kodiak	10		1.29	.00	.31	Mar 68	([c])			
	Nome	2		.00	.00	.00	Sept 67	([c])			
	Pt. Barrow	20		1.25	.55	1.04	June 68	([c])			
	St. Paul Island	27		.87	.42	.47	Oct 67	([c])			
Ariz:	Phoenix	17		14.60	.96	4.86	Feb 68	([c])			
Ark:	Little Rock	14	6	1.92	.29	.84	Dec 67	20	0	0	
Calif:	Berkeley	19	6	.74	.00	.22	Mar 68	75	6	75	0
	Los Angeles	19	3	2.73	.40	.96	Sept 67	12	3	12	0
C. Z:	Ancon	15		3.12	.96	1.90	Mar 68	([c])			
Colo:	Denver	18	4	5.81	.56	1.74	Mar 68	9	([d])	([d])	([d])
Conn:	Hartford	18	2	1.07	.19	.31	Jan 68	17	2	17	0
Del:	Dover	11		1.71	.25	.64	Nov 67	([c])			
D. C:	Washington	23	1	1.54	.27	.86	June 68	10	1	10	0
Fla:	Jacksonville	21	7	1.21	.30	.62	Dec 67	58	6	74	0
	Miami	17	4	.96	.24	.43	Jan 68	66	4	66	0
Ga:	Atlanta	19		2.02	.51	1.22	Oct 67	([c])			
Guam:	Agana	20		1.04	.00	.38	Nov 67	([c])			
Hawaii:	Honolulu	29	1	.91	.30	.65	May 68	22	([d])	([d])	([d])
Idaho:	Boise	21	6	3.26	.34	1.64	May 68	56	6	56	0
Ill:	Springfield	19	3	3.83	.35	1.26	June 68	41	0	0	
Ind:	Indianapolis	19	3	1.76	.54	.85	Oct 67	41	3	41	31
Iowa:	Iowa City	20		1.62	.00	1.06	Mar 68	([c])			
Kans:	Topeka	21	4	3.01	.45	1.12	Dec 67	20	4	20	14
Ky:	Frankfort	10		1.51	.50	.81	June 68	([c])			
La:	New Orleans	17	5	1.25	.23	.59	June 68	97	([d])	([d])	([d])
Maine:	Augusta	20	3	.79	.00	.23	Feb 68	13	4	13	4
Md:	Baltimore	19	1	4.07	.26	.99	Jan 68	10	1	10	11
	Rockville	([b])					May 68	([c])			
Mass:	Lawrence	20	1	1.51	.00	.43	Nov 67	11	0	0	
	Winchester	19	2	1.33	.00	.18	Apr 68	6	2	6	0
Mich:	Lansing	20		1.42	.35	.60	May 68	([c])			
Minn:	Minneapolis	18	1	.24	.14	.22	Nov 67	2	1	2	3
Miss:	Jackson	9	2	1.14	.35	.65	Feb 68	37	2	37	0
	Jefferson City	19	3	1.45	.19	.70	Oct 67	15	3	15	0
Mont:	Helena	19	3	1.89	.16	.55	Apr 68	4	3	4	6
Nebr:	Lincoln	19	1	3.56	.96	1.90	Oct 67	2	1	2	0
Nev:	Las Vegas	16		3.61	1.06	2.27	Jan 68	([c])			
N. H:	Concord	20		.98	.00	.45	June 68	([c])			
N. J:	Trenton	19	1	2.83	.20	.64	Feb 68	4	1	4	0
N. Mex:	Santa Fe	20	6	1.03	.21	.56	Apr 68	21	3	21	3
N. Y:	Albany	20	1	2.70	.23	.58	Oct 67	4	1	4	1
	Buffalo	17		.74	.00	.27	Mar 68	([c])			
	New York	18		.66	.05	.43	Apr 68	([c])			
N. C:	Gastonia	17	1	18.40	1.43	5.30	Mar 68	14	([d])	([d])	([d])
N. Dak:	Bismarck	19	1	.59	.00	.36	June 68	2	0	0	
Ohio:	Cincinnati	17		3.71	.40	1.27	Nov 67	([c])			
	Columbus	18	2	2.59	.00	.69	Feb 68	7	1	2	0
	Painesville	19	6	.89	.21	.35	Jan 68	11	6	11	4
Okla:	Oklahoma City	14	1	3.02	.33	.96	May 68	4	1	4	0
	Ponca City	22	2	8.95	.00	1.33	Jan 68	10	2	10	0
Ore:	Portland	18	7	.86	.00	.34	Oct 67	70	7	70	0
Pa:	Harrisburg	17		4.65	.40	1.08	Oct 67	([c])			
P. R:	San Juan	([b])					Feb 68	([c])			
R. I:	Providence	17	1	.37	.00	.26	May 68	25	0	0	
S. C:	Columbia	8	2	.57	.27	.43	Apr 68	7	0	0	
S. Dak:	Pierre	17		4.91	.46	1.88	Feb 68	([c])			
Tenn:	Nashville	15	5	1.51	.30	.71	May 68	11	4	10	0
Tex:	Austin	20	6	6.41	.77	2.58	Nov 67	43	([d])	([d])	([d])
	El Paso	21	5	6.08	.84	2.57	June 68	30	5	30	0
Utah:	Salt Lake City	29	10	.81	.23	.46	Sept 67	57	0	0	
Vt:	Barre	19	4	.73	.00	.28	Dec 67	13	4	13	0
Va:	Richmond	14	2	.89	.38	.63	Dec 67	11	0	0	
Wash:	Seattle	6	9	.95	.00	.42	Dec 67	89	([d])	([d])	([d])
	Spokane	19	3	2.52	.47	1.10	Nov 67	13	0	0	
W. Va:	Charleston	19	3	2.10	.24	.78	Apr 68	7	3	7	1
Wis:	Madison	14	3	.55	.12	.33	Dec 67	12	3	12	15
Wyo:	Cheyenne	19	3	6.38	.78	1.84	Jan 67	9	3	9	10
Network summary		1,240	175	18.40	0.00	0.95		28	3	19	2

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] No report received. (Air samples showing no field estimate are ignored).
[c] No precipitation sample collected.
[d] This station is part of the plutonium in precipitation network. No gross beta measurements are done.

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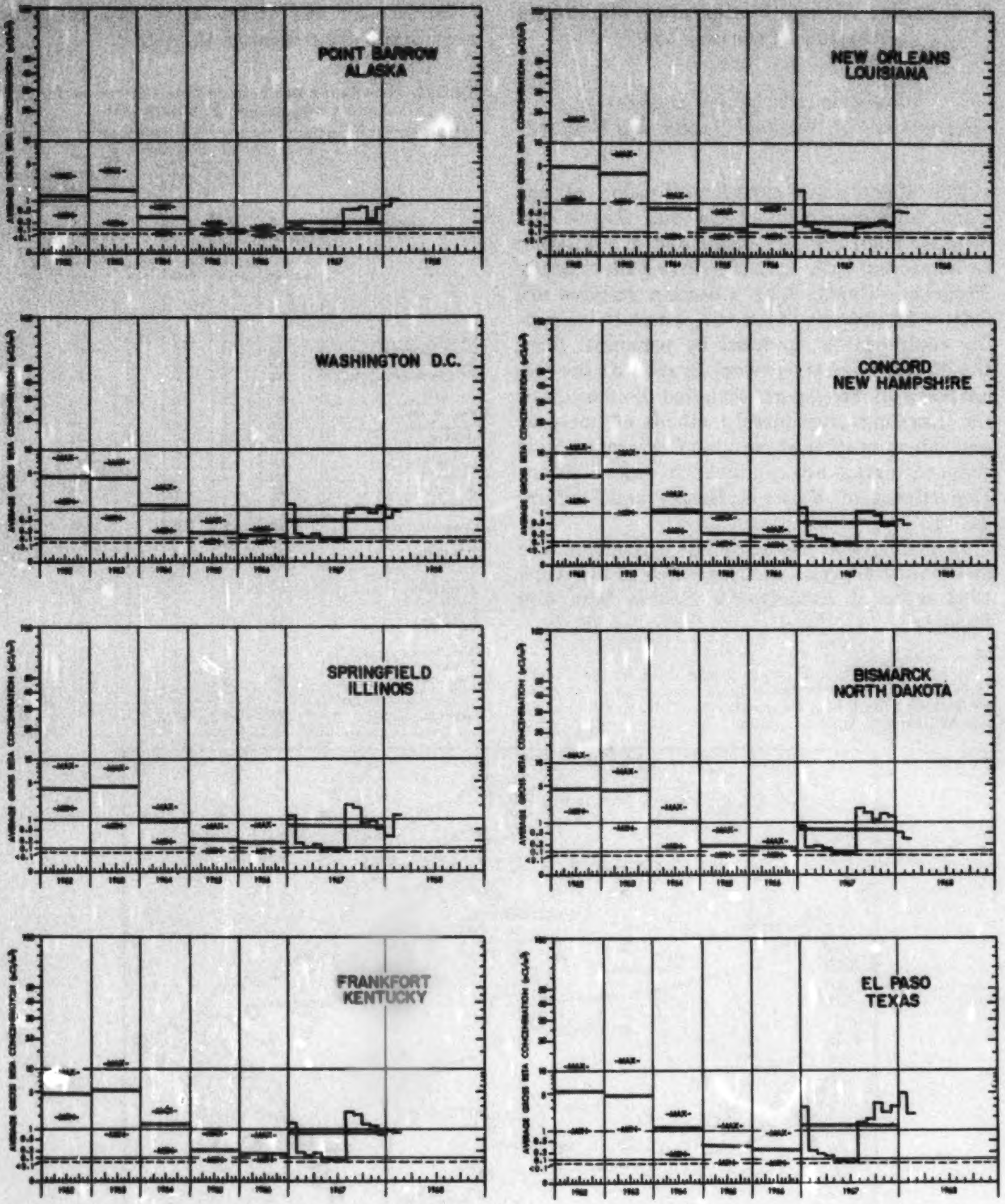

Figure 2. Monthly and yearly profiles of beta radioactivity in air—Radiation Alert Network, 1962–February 1968

2. Canadian Air and Precipitation Monitoring Program, February 1968[1]

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 3), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*2–6*).

A summary of the sampling procedures and methods of analysis was presented in the April 1968 issue of *Radiological Health Data and Reports*.

Surface air and precipitation data for February 1968 are presented in table 2.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, February 1968

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentrations (pCi/liter)	Total deposition (nCi/m²)
Calgary	29	0.6	0.0	0.3	285	0.7
Coral Harbour	29	.3	.0	.1	98	3.6
Edmonton	29	.4	.0	.2	271	.8
Ft. Churchill	29	.2	.0	.1	25	.5
Ft. William	23	.3	.0	.2	130	.8
Fredericton	28	.3	.0	.1	48	1.6
Goose Bay	29	.2	.0	.1	32	3.1
Halifax	29	.3	.0	.1	44	3.4
Inuvik	29	.3	.0	.1	80	1.3
Montreal	29	.4	.1	.2	39	1.5
Moosonee	29	.3	.0	.1	14	.2
Ottawa	29	.4	.1	.1	45	1.4
Quebec	29	.2	.0	.1	65	2.7
Regina	27	.3	.0	.2	249	1.2
Resolute	28	.2	.0	.1	15	.3
St. John's, Nfld	29	.3	.0	.1	13	2.1
Saskatoon	29	.3	.0	.1	166	.6
Saulte Ste Marie	25	.4	.1	.2	21	1.7
Toronto	29	.2	.0	.2	44	1.6
Vancouver	29	.3	.0	.1	70	7.3
Whitehorse	29	.3	.0	.1	217	1.0
Windsor	29	.2	.0	.1	24	1.1
Winnipeg	29	.2	.0	.1	274	1.3
Yellowknife	29	.2	.0	.1	35	.3
Network summary	28	0.6	0.0	0.1	97	1.6

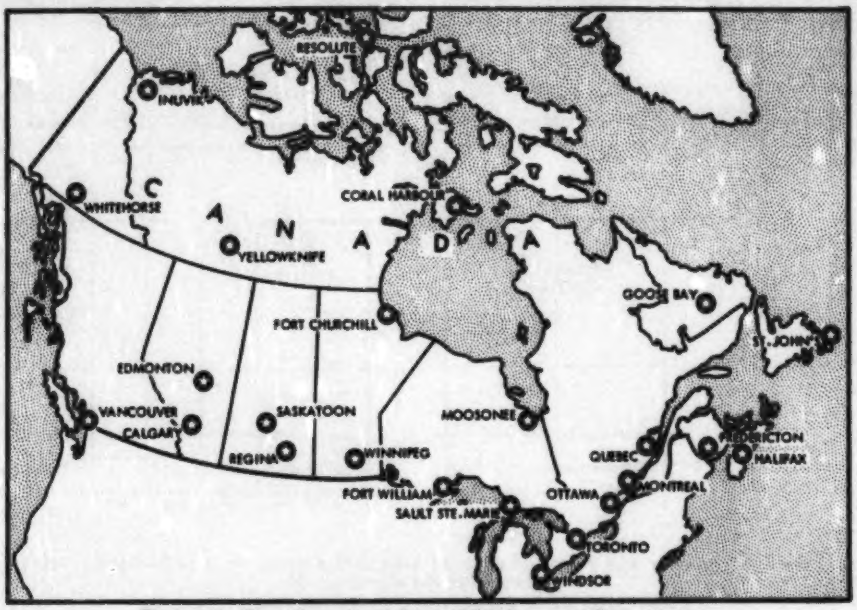
RESOLUTE
INUVIK
WHITEHORSE
C A N A D A
CORAL HARBOUR
YELLOWKNIFE
GOOSE BAY
FORT CHURCHILL
ST. JOHN'S
EDMONTON
VANCOUVER
CALGARY
SASKATOON
MOOSONEE
REGINA
WINNIPEG
FREDERICTON
QUEBEC
HALIFAX
FORT WILLIAM
MONTREAL
OTTAWA
SAULT STE. MARIE
TORONTO
WINDSOR

Figure 3. Canadian air and precipitation sampling stations

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[1] Prepared from information and data in the March 1968 monthly report "Data from Radiation Protection Program" Canadian Department of National Health and Welfare, Ottawa, Canada.

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3. Mexican Air Monitoring Program
February 1968

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico was established by the Comisión Nacional de Energía Nuclear (CNEN), Mexico, D.F. From 1952 to 1961, the network was directed by the Institute of Physics of the University of México, under contract to the CNEN.

In 1961, the CNEN appointed its Division of Radiological Protection to establish a new Radiation Surveillance Network. In 1966, the Division of Radiological Protection was restructured and its name changed to Dirección General de Seguridad Radiológica (DRS). The network consists of 16 stations (figure 4), 11 of which are located at airports and operated by airline personnel. The remaining five stations are located at México, D.F.; Mérida; Veracruz; San Luis Potósi; and Ensenada. Staff members of the DRS operate the station at México D.F., while the other four stations are manned by members of the Centro de Previsión del Golfo de México, the Chemistry Department of the University of Mérida, the Institute de Zonas Desérticas of the University of San Luis Potosí, and the Escuela Superior de Ciencias Marinas of the University of Baja California, respectively.

Sampling

The sampling procedure involves drawing air through a high-efficiency 6 by 9-inch glass-fiber filter for 20 hours a day, 3 or 4 days a week at the rate of 1,000 cubic meters per day using high volume samplers.

After each 20-hour sampling period, the filter is removed and shipped via airmail to the Sección de Radioactividad Ambiental, CNEN, in México, D.F., for assay of gross beta radioactivity, allowing a minimum of 3 or 4 days after collection for the decay of radon and thoron. The data are not extrapolated to the time of collection. Statistically, it has been found that a minimum of five samples per month were needed to get a reliable average radioactivity at each station (7).

The maximum, minimum, and average beta radioactivity in surface air during February 1968 are presented in table 3.

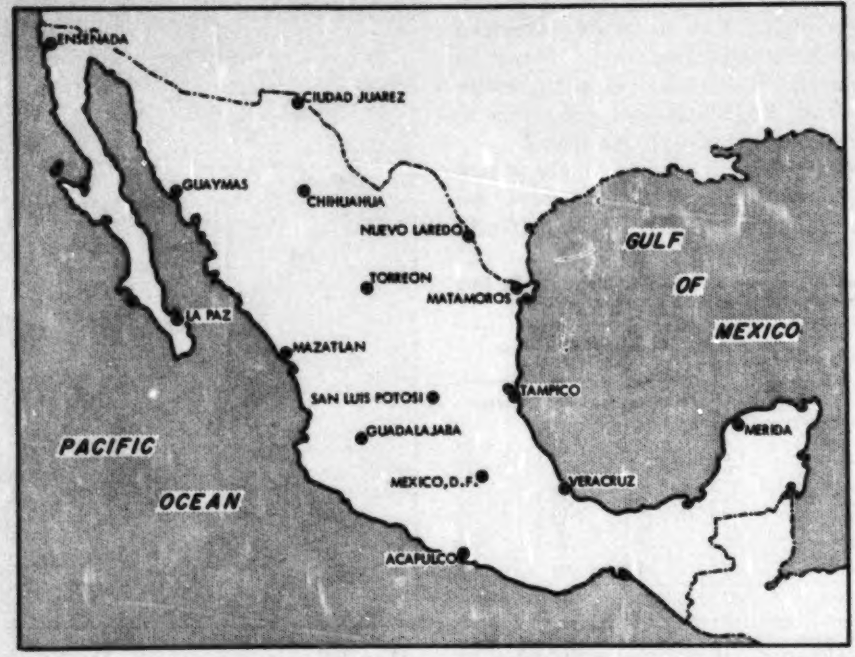

Figure 4. Mexican air sampling locations

Table 3. Mexican gross beta radioactivity of airborne particulates, February 1968

Station	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average
Acapulco	11	0.3	0.1	0.1
Chihuahua	13	.9	.1	.4
Ciudad Juárez	7	.8	.3	.5
Ensenada	3	.5	.4	
Guadalajara	NS			
Guaymas	NS			
La Paz	NS			
Matamoros	NS			
Mazatlán	10	.3	.2	.3
Mérida	NS			
México, D. F.	8	1.0	.1	.4
Nuevo Laredo	NS			
San Luis Potosí	NS			
Tampico	3	.1	.1	
Torreón	5	.4	.2	.3
Veracruz	5	.7	.1	.4

NS, no sample, station temporarily shutdown.

4. Pan American Air Sampling Program February 1968

Pan American Health Organization and *U.S. Public Health Service*

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the U.S. Public Health Service (PHS) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 5. Analytical techniques were described in the January 1968 *Radiological Health Data and Reports*. The February 1968 air monitoring results from the participating countries are given in table 4.

Table 4. Summary of gross beta radioactivity in Pan American surface air, February 1968

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average [a]
Argentina:	Buenos Aires	6	0.03	0.02	0.03
Bolivia:	La Paz	16	.02	.00	.01
Chile:	Santiago	9	.03	.01	.02
Colombia:	Bogota	21	.10	.02	.05
Ecuador:	Guayaquil	18	.05	.02	.03
Jamaica:	Kingston	18	.36	.04	.15
Peru:	Lima	16	.05	.01	.02
Venezuela:	Caracas	13	.13	.03	.07
West Indies:	Trinidad	19	.21	.03	.10
Pan American summary		136	0.36	0.00	0.06

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

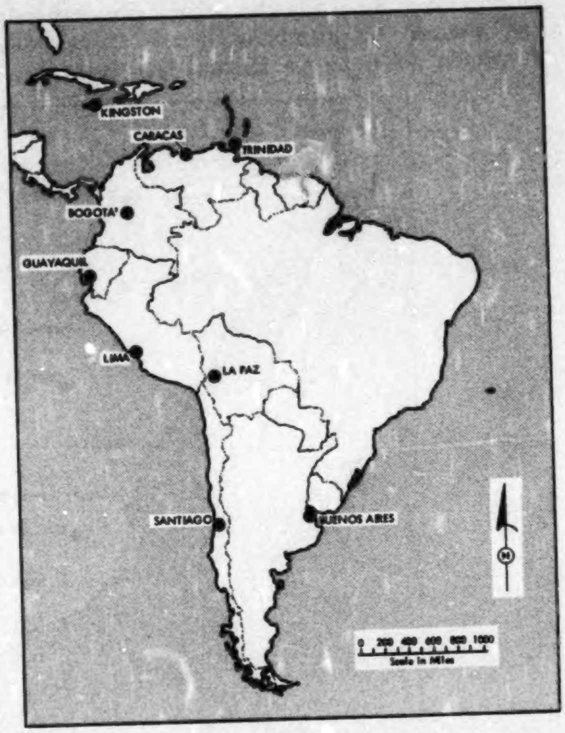

Figure 5. Pan American Air Sampling Program stations

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(*2*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW–RP–3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*3*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW–RP–4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

(*4*) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW–RP–5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*5*) BEALE, J. and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD–11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*6*) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD–21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

(*7*) VASQUEZ, M., and R. M. DE NULMAN. Estudios sobre la radioactividad ambiental en la República Méxicana, 1963–1965. Comisión Nacional de Energía Nuclear, Dirección General de Seguridad Radiológica (in press 1966).

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, bovine thyroid sampling, Alaskan surveillance and environmental monitoring around nuclear facilities.

Radionuclides In Alaska Caribou and Reindeer, August–October 1967

National Center for Radiological Health
U.S. Public Health Service

Under a cooperative agreement between the Alaskan Department of Health and Welfare, the Alaskan Department of Fish and Game, and the U.S. Public Health Service, an active program of caribou and reindeer sampling and analysis was undertaken in 1963 to aid in the assessment of radionuclide intake of Alaskan residents. This joint sampling activity was continued based on the results of a limited sampling effort conducted by these groups in 1962.

Through the second quarter of 1964, the sampling was confined to the three principal caribou herds and one privately-owned reindeer herd. This program was expanded in September 1964, when the sampling of additional privately owned and government-owned reindeer herds was begun through the assistance of the Fish and Wildlife Service and the Bureau of Indian Affairs, Department of Interior.

Figure 1 shows the locations of the principal caribou and reindeer herds in Alaska. The code indicates the herds that were sampled during the fall of 1967.

For the present program, samples are taken in the spring and fall from selected caribou and reindeer herds. Samples of muscle and rumen contents of five animals from each herd are collected during the sampling period. Hock joint bones from five animals are collected only from the Nome herd during the fall collection peribd. Muscle samples are analyzed individually and rumen content samples from each herd are composited before analysis for cesium–137 by gamma-ray spectroscopy. Muscle and bone samples from the individual herd are composited before analysis of strontium–89 and strontium–90. All samples are analyzed at the Public Health Service's Southwestern Radiological Health Laboratory in Las Vegas, Nev.

Strontium-89, strontium-90, and cesium-137 data are presented in table 1 for caribou muscle, reindeer muscle and rumen contents for the August-October 1967 collection period. The muscle data are of prime interest, since muscle is an important constituent of the diet for many Alaskan residents. A comparison of the muscle data is shown in table 2.

The cesium-137 concentrations in muscle in the fall of 1967 have decreased considerably as compared to the fall of 1966. The only exception is the Shishmaref reindeer herd. This may be due to the fact that the 1966 sample was collected in July rather than during October as in 1967. The cesium-137 concentrations in the summer are usually quite low compared to concentrations in the fall. A summary of the strontium-90 and cesium-137 concentrations in foodstuffs in Alaska (including reindeer and caribou meat) is contained in the December 1966 issue of *Radiological Health Data and Reports.*

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
October-November 1966	May 1967
March-May 1967	January 1968

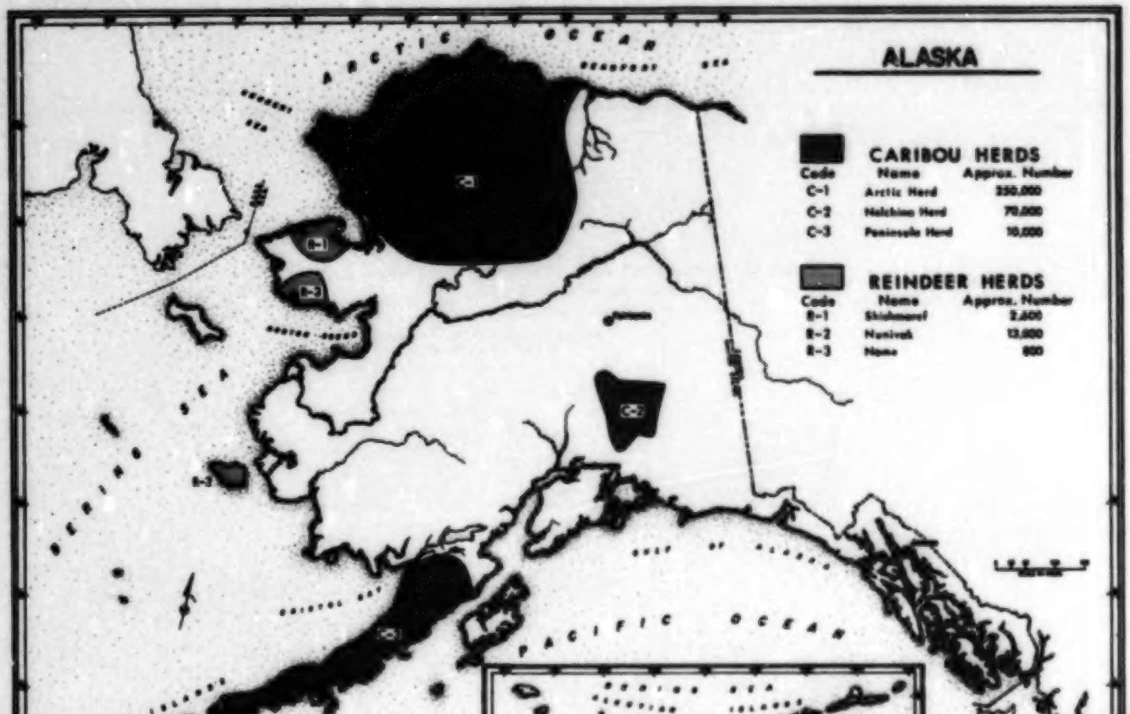
ALASKA
CARIBOU HERDS
Code Name Approx. Number
C-1 Arctic Herd 250,000
C-2 Nelchina Herd 70,000
C-3 Peninsula Herd 10,000
REINDEER HERDS
Code Name Approx. Number
R-1 Shishmaref 2,600
R-2 Nunivak 13,000
R-3 Nome 600
ARCTIC OCEAN
BERING SEA
PACIFIC OCEAN
GULF OF ALASKA
C-1
C-2
C-3
R-1
R-2
R-3

Figure 1. Location of caribou and reindeer herds in Alaska

Table 1. Radionuclide concentrations in muscle and rumen of Alaska caribou and reindeer August–October 1967

Herd and sampling location [a]	Collection date, 1967	Sex	Age (years)	Muscle (pCi/kg wet weight)			Rumen (pCi/kg wet weight)
				^{89}Sr [b]	^{90}Sr [b]	^{137}Cs	^{137}Cs
Arctic caribou herd, Anaktuvuk Pass, C-1	10/16 10/16 10/16 10/16 10/16	F M M F F	5 9 2 9 4	4	33	5.0 x 10^3 6.5 x 10^3 6.1 x 10^3 4.9 x 10^3 4.8 x 10^3	4.8 x 10^3
Nelchina caribou herd, Dickey Lake, C-2	9/16 9/16 9/16 9/20 9/20	F F F F F	Calf 3 4 6 Calf	5	19	9.9 x 10^3 3.9 x 10^3 3.4 x 10^3 5.3 x 10^3 7.4 x 10^3	6.3 x 10^3
Peninsula caribou herd, King Salmon, C-3	10/4 10/4 10/4 10/4 10/4	F F M M F	2 2 4 3 Calf	26	66	10.2 x 10^3 14.6 x 10^3 11.7 x 10^3 6.6 x 10^3 13.0 x 10^3	8.1 x 10^3
Shishmaref reindeer herd, Seward Peninsula, R-4	10/31 10/31 10/31 10/31 10/31	M M M M M	5 4 4 4 4	5	53	11.0 x 10^3 13.5 x 10^3 11.0 x 10^3 8.9 x 10^3 8.5 x 10^3	4.6 x 10^3
Nunivak Island reindeer herd, R-8	8/24 8/24 8/24 8/24 8/24	F M F F F	3 2 2 2 2	16	18	2.7 x 10^3 3.0 x 10^3 3.9 x 10^3 3.0 x 10^3 3.9 x 10^3	1.7 x 10^3
Nome reindeer herd, R-10	8/31 9/1 9/1 9/1 8/31 8/31	F F F F F F	—[c] — — 2 — —	98	177	13.9 x 10^3 13.5 x 10^3 11.7 x 10^3 25.8 x 10^3 9.0 x 10^3 11.0 x 10^3	9.4 x 10^3

[a] Sampling locations are shown in figure 1.
[b] Composite of individual samples taken within the herd.
[c] Ages not available.

Table 2. Cesium-137 concentrations in caribou and reindeer muscles, fall 1966–1967

Herd	Average cesium-137 concentration (pCi/kg wet weight)	
	1966	1967
Arctic caribou	17.0 x 10^3 (October)	5.9 x 10^3 (October)
Nelchina caribou	13.0 x 10^3 (November)	5.8 x 10^3 (September)
Peninsula caribou	20.0 x 10^3 (November)	11.2 x 10^3 (October)
Shishmaref reindeer	3.6 x 10^3 (July)	10.6 x 10^3 (October)
Nunivak reindeer	6.7 x 10^3 (August)	3.5 x 10^3 (August)
Nome reindeer	25.0 x 10^3 (November)	14.2 x 10^3 (September)

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Strontium–90 in Human Bone, January–March 1967[1]

National Center for Radiological Health
Public Health Service

To obtain data on the concentration of strontium–90 in man by age and geographical region, the Public Health Service began collecting human bone specimens in late 1961. Analyses of selected samples of people in older age groups have shown their bone strontium–90 content to be low and age-independent (*1*). Consequently, the target population includes children and young adults up to 25 years of age.

Although a few samples come from living persons as a result of surgical procedures, the majority are obtained post mortem. In the latter case, the specimens are limited to accident victims or persons who have died of an acute disease process that was not likely to impair bone metabolism. For analytical purposes, a sample of at least 100 grams of wet bone is desired. Generally, this amount is readily available from older children, but it presents some difficulties from the standpoint of infants and children under 5 years of age.

Most specimens received to date have been vertebrae and ribs. Efforts to collect long bones for comparison of results with British data have not been successful.

Laboratory procedures

The bones are analyzed at the Northeastern Radiological Health Laboratory of the National Center for Radiological Health, at Winchester, Mass. Sample collection and preparation are explained elsewhere (*2*). Strontium–90 is measured by tributyl phosphate extraction of its yttrium daughter, which is precipitated as an oxalate. The stronium–90 content is then calculated (*3*) from the yttrium–90 radioac-

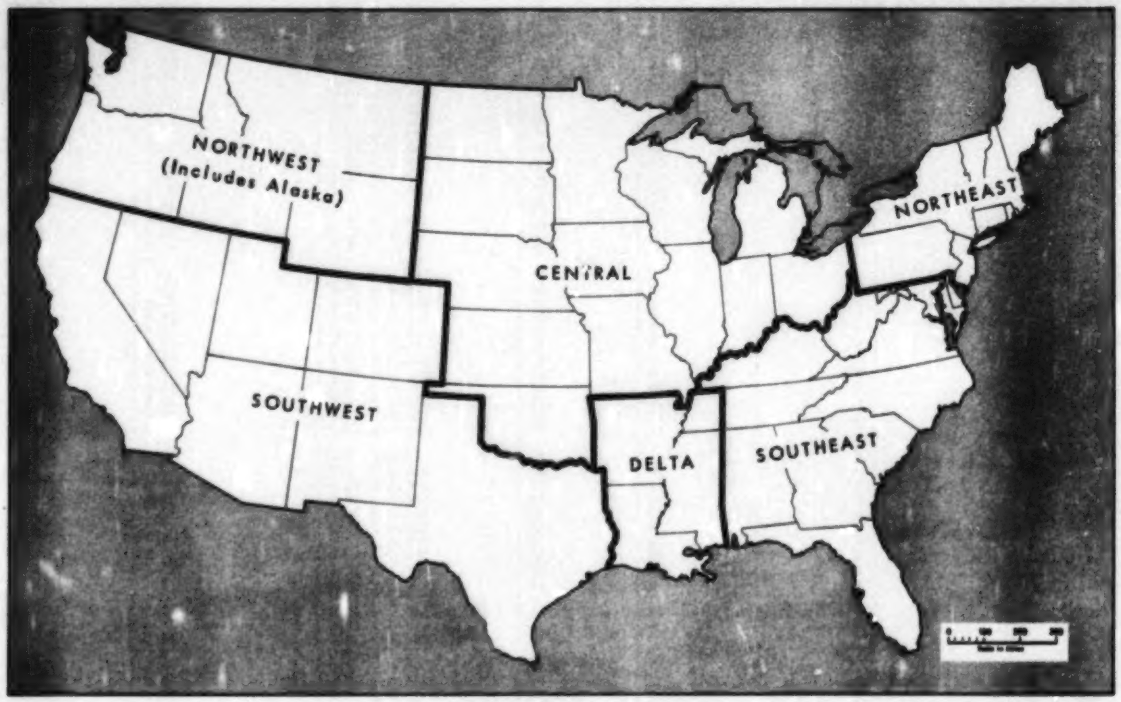

Figure 1. Geographical regions for human bone sampling

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[1] Period during which death or surgical procedure occurred.

Table 1. Strontium-90 in human bone, January–March 1967

Bone region and State of residence	Bone type [a]	Age [b] (years)	Sex	Strontium-90 concentration (pCi/kg bone)	Calcium concentration (g/kg bone)	^{90}Sr/Ca (pCi/g)
Northeast:						
N. Y.	V, R	0	F	59.0 ± 8.7	[c]48.7	1.21
N. Y.	V, R, F	0	M	31.9 ± 4.9	30.0	1.06
N. Y.	V	1	M	79.9 ± 15.0	28.8	2.77
Mass.	V	2	F	178.0 ± 14.0	30.4	5.85
Conn.	V	2	F	79.9 ± 11.0	26.4	3.02
Vt.	V	2	F	140.0 ± 8.7	34.5	4.05
N. Y.	V	2	F	173.0 ± 17.0	30.8	5.61
Mass.	V	2	F	135.0 ± 13.0	28.9	4.67
Mass.	V	3	M	150.0 ± 13.0	36.1	4.15
Mass.	V	3	M	112.0 ± 14.0	32.4	3.45
N. Y.	V	3	M	119.0 ± 13.0	33.2	3.58
N. Y.	V	3	F	92.9 ± 14.0	30.5	3.04
Mass.	V	4	M	63.9 ± 11.0	26.1	2.44
Mass.	V	4	M	283.0 ± 18.0	42.2	6.70
Mass.	V	5	M	62.9 ± 9.3	26.6	2.36
Vt.	V	5	M	190.0 ± 15.0	39.8	4.77
N. Y.	V	5	M	48.0 ± 6.7	27.9	1.72
N. Y.	V	5	M	56.2 ± 9.3	20.1	2.79
N. Y.	V	5	M	72.2 ± 12.0	35.1	2.05
Mass.	V	6	M	117.0 ± 10.0	33.5	3.49
R. I.	V	6	F	121.0 ± 14.0	33.1	3.65
Mass.	V	6	M	154.0 ± 14.0	32.4	4.75
Mass.	V	6	M	69.3 ± 8.7	29.1	2.38
Vt.	V	6	F	118.0 ± 10.0	37.8	3.12
N. Y.	V	6	F	81.7 ± 9.9	36.8	2.22
Mass.	V	8	F	134.0 ± 11.0	37.7	3.55
N. Y.	V	8	M	106.0 ± 13.0	39.0	2.71
N. H.	V	9	M	82.1 ± 8.2	32.1	2.55
Maine	V	10	M	92.9 ± 8.4	32.1	2.89
Mass.	V	10	M	82.0 ± 8.1	33.4	2.45
Vt.	V	10	F	20.2 ± 5.7	43.4	0.46
N. Y.	V	10	F	84.5 ± 11.0	30.8	2.74
N. Y.	V	10	F	72.4 ± 9.0	35.2	2.05
N. Y.	V	10	F	159.0 ± 12.0	47.3	3.36
Mass.	V	11	F	128.0 ± 8.5	42.5	3.01
Mass.	V	11	M	66.3 ± 10.0	35.5	1.86
Vt.	V	12	F	229.0 ± 22.0	50.6	4.52
Conn.	V, R	12	F	101.0 ± 10.0	33.8	2.98
Mass.	V	13	F	62.4 ± 13.0	28.3	2.20
Pa.	V	13	M	39.4 ± 8.5	27.7	1.42
Maine	V	14	M	88.9 ± 8.5	34.4	2.58
Vt.	V	14	F	212.0 ± 11.0	53.9	3.93
N. Y.	V	15	M	209.0 ± 13.0	61.9	3.37
N. H.	V	16	F	157.0 ± 10.0	52.8	2.97
N. Y.	V	16	M	184.0 ± 14.0	59.2	3.10
Vt.	V	18	M	152.0 ± 12.0	53.8	2.82
N. Y.	V	18	F	80.4 ± 11.0	43.7	1.83
Conn.	V, R	18	M	133.0 ± 11.0	45.0	2.95
Conn.	V	18	M	206.0 ± 12.0	82.7	2.49
Vt.	V	19	F	97.1 ± 11.0	56.3	1.72
N. Y.	V	19	F	59.9 ± 8.4	39.4	1.52
Conn.	V, R	21	M	51.7 ± 7.3	30.2	1.71
N. Y.	V	21	M	49.3 ± 6.2	44.0	1.12
Mass.	V	22	M	174.0 ± 12.0	53.2	3.27
N. Y.	V	25	M	77.9 ± 9.1	43.2	1.80
Southeast:						
N. C.	V	0	M	39.3 ± 10.0	32.1	1.22
Md.	V	2	M	142.0 ± 17.0	27.4	5.18
Md.	V	3	F	127.0 ± 18.0	34.8	3.64
Md.	V	5	M	115.0 ± 11.0	31.8	3.61
N. C.	V	5	F	81.7 ± 10.0	26.3	3.10
Md.	V	6	F	125.0 ± 13.0	36.7	3.40
Md.	V	8	M	115.0 ± 11.0	37.0	3.10
N. C.	V	9	M	78.8 ± 9.5	31.2	2.52
Md.	V	10	M	114.0 ± 11.0	46.8	2.43
Md.	V	10	M	128.0 ± 11.0	28.4	4.50
Fla.	V	11	M	44.6 ± 5.8	31.3	1.42
Md.	V	11	M	97.2 ± 8.4	33.8	2.87
Md.	V	15	F	226.0 ± 14.0	62.6	3.61
Md.	V	15	M	116.0 ± 12.0	56.6	2.04
Md.	V	16	M	155.0 ± 14.0	56.2	2.75
Md.	V	17	M	200.0 ± 16.0	52.7	3.79
Md.	V	18	M	125.0 ± 13.0	61.6	2.02
Md.	V	18	M	175.0 ± 14.0	67.4	2.59
Md.	V	18	M	145.0 ± 12.0	58.8	2.46
S. C.	V	18	M	131.0 ± 11.0	46.8	2.79
Ky.	V	19	M	137.0 ± 9.0	73.1	1.87
Md.	V	20	M	111.0 ± 13.0	60.2	1.84
Md.	V	20	M	113.0 ± 13.0	56.3	2.00
Md.	V	20	F	93.3 ± 8.7	56.4	1.65
Md.	V	20	M	118.0 ± 12.0	58.2	2.02
Md.	V	21	M	79.6 ± 10.0	54.7	1.45
Md.	V	21	M	124.0 ± 17.0	59.8	2.07
Md.	V	21	M	71.0 ± 9.9	37.1	1.91
Md.	V	22	M	145.0 ± 11.0	54.6	2.65

See footnotes at end of table.

Table 1. Strontium-90 in human bone, January–March 1967—Continued

Bone region and State of residence	Bone [a] type	Age [b] (years)	Sex	Strontium-90 concentration (pCi/kg bone)	Calcium concentration (g/kg bone)	^{90}Sr/Ca (pCi/g)
Southeast: (continued)						
Md:	V	22	F	120.0 ± 14.0	58.5	2.05
N. C:	V	23	F	81.0 ± 10.0	47.9	1.69
Md:	V	24	M	100.0 ± 12.0	57.1	1.75
Md:	V	24	M	173.0 ± 12.0	67.7	2.55
Md:	V	26	M	68.6 ± 11.0	41.5	1.65
Md:	V	24	F	67.7 ± 10.0	56.5	1.19
Central:						
Wis:	V	0	F	68.7 ± 17.0	53.0	1.30
Wis:	V	1	M	92.5 ± 14.0	29.6	3.12
Wis:	V	1	F	87.1 ± 13.0	36.3	2.39
Wis:	V	1	M	143.0 ± 12.0	31.9	4.48
Wis:	V	1	M	47.5 ± 9.1	30.9	1.53
Wis:	V	2	F	60.8 ± 9.3	27.0	2.25
Ohio:	V	2	F	73.9 ± 10.0	32.7	2.25
Wis:	V	3	M	123.0 ± 11.0	29.7	4.14
Wis:	V	3	M	69.5 ± 7.3	25.7	2.70
Ohio:	V	3	F	191.0 ± 15.0	50.4	3.79
Ohio:	V	5	M	91.7 ± 16.0	32.5	2.82
Ohio:	V	6	M	107.0 ± 11.0	54.7	1.96
Ohio:	V	7	F	208.0 ± 13.0	34.5	6.03
Ohio:	V	8	F	50.2 ± 10.0	33.5	1.50
Ohio:	V	8	F	78.0 ± 11.0	55.2	1.41
Ohio:	V	11	M	150.0 ± 12.0	61.0	2.46
Ohio:	V	12	M	195.0 ± 15.0	73.4	2.66
Minn:	V	12	M	87.1 ± 10.0	45.5	1.91
Ohio:	V	15	M	130.0 ± 10.0	58.7	2.21
Ohio:	V	16	F	155.0 ± 9.7	68.7	2.26
Ohio:	V	16	M	136.0 ± 9.8	70.8	1.92
Mo:	V	16	M	154.0 ± 11.0	60.3	2.55
Minn:	V	16	M	100.0 ± 10.0	36.6	2.73
Mich:	V	21	M	59.6 ± 7.6	47.4	1.26
Ohio:	V	16	M	472.0 ± 26.0	82.1	5.74
Ohio:	V	17	M	157.0 ± 9.6	70.4	2.23
Ohio:	V	17	M	132.0 ± 10.0	60.7	2.17
Ohio:	V	17	M	120.0 ± 9.6	63.8	1.88
Ohio:	V	18	M	180.0 ± 12.0	73.4	2.45
Ohio:	V	18	M	109.0 ± 10.0	66.3	1.64
Ohio:	V	18	F	135.0 ± 12.0	65.9	2.04
Ohio:	V	18	M	175.0 ± 16.0	74.1	2.36
Ohio:	V	18	M	160.0 ± 15.0	88.7	1.80
Ohio:	V	19	M	156.0 ± 14.0	71.8	2.17
Ohio:	V	19	F	181.0 ± 13.0	83.6	2.16
Ohio:	V	19	M	120.0 ± 11.0	78.7	1.52
Ohio:	V	19	M	223.0 ± 15.0	75.3	2.96
Ohio:	V	20	M	115.0 ± 8.9	73.0	1.57
Ohio:	V	21	M	155.0 ± 9.6	89.1	1.73
Ohio:	V	21	F	108.0 ± 9.5	73.9	1.46
Ohio:	V	21	M	164.0 ± 11.0	61.1	2.68
Ohio:	V	22	M	125.0 ± 9.6	77.1	1.62
Ohio:	V	24	F	138.0 ± 10.0	72.5	1.90
Ohio:	V	24	M	161.0 ± 11.0	75.8	2.12
Ohio:	V	25	M	92.3 ± 8.9	67.3	1.37
Ohio:	V	25	F	102.0 ± 7.8	97.9	1.04
Ohio:	V	25	M	72.5 ± 10.0	72.5	1.00
Ohio:	V	25	M	110.0 ± 8.9	81.6	1.34
Minn:	V	25	M	93.2 ± 15.0	40.5	2.30
Delta:						
La:	V	1	M	274.0 ± 21.0	37.2	7.36
La:	V, R	5	F	112.0 ± 12.0	39.0	2.87
Miss:	V	6	F	180.0 ± 13.0	32.2	5.59
La:	V, R	7	F	186.0 ± 17.0	36.7	5.06
La:	V, R	11	F	104.0 ± 11.0	40.2	2.59
La:	V	21	M	68.9 ± 7.0	44.5	1.54
Northwest:						
Oreg:	V	0	M	50.2 ± 10.0	27.7	1.81
Oreg:	V	1	M	82.3 ± 10.0	32.0	2.57
Oreg:	V	1	M	113.0 ± 11.0	28.8	3.92
Oreg:	V	3	M	107.0 ± 10.0	28.8	3.71
Oreg:	V	9	M	76.3 ± 9.2	39.3	1.94
Oreg:	V	13	M	118.0 ± 10.0	41.0	2.87
Wash:	V	14	M	109.0 ± 8.0	48.5	2.24
Oreg:	V	21	M	75.3 ± 9.4	47.8	1.57
Wash:	V	21	F	140.0 ± 11.0	53.7	2.60
Wash:	V	22	M	75.3 ± 9.5	41.5	1.81
Wash:	V	22	F	58.7 ± 10.0	44.4	1.32
Alaska	R	13	M	150.0 ± 78.0	23.0	6.54
Alaska	R	17	M	303.0 ± 58.0	57.0	5.32
Alaska	R	17	F	277.0 ± 50.0	55.0	4.36
Alaska	R	22	F	183.0 34.0	53.0	1.19
Southwest:						
Tex:	V	17	M	150.0 ± 11.0	65.6	2.29
Calif:	V	22	F	88.5 ± 9.5	53.1	1.66
Tex:	V	23	M	34.2 ± 11.0	37.0	0.92

[a] Type of bone: V, vertebrae; R, rib; F, femur. [b] Age given as of last birthday prior to death. [c] Two standard deviation counting error.

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tivity. For the purpose of maintaining analytical reproducibility, duplicate analyses are performed on 10 to 20 percent of the samples introduced randomly into the schedule of analysis. To further check and maintain analytical accuracy, samples are analyzed periodically and crosscheck analyses are carried out quarterly with the Health and Safety Laboratory of the AEC, which performs similar analyses.

The analytical results for strontium-90 in individual bones from persons dying during the first quarter (January–March) of 1967 are presented in table 1 in order of increasing age within each geographical region. These regions are indicated in figure 1. Reported values are given in picocuries of strontium-90 per kilogram of bone (as a rough indication of dose) and per gram of calcium (for comparison with other data and for purposes of model development). Two-sigma counting errors are reported for the bone concentration.

Following the pattern of earlier reports, subsequent articles will continue to provide interpretation of the data at appropriate stages in the program (*2–5*).

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
January–March 1966	February 1967
April–June 1966	March 1967
July–September 1966	July 1967
October–December 1966	September 1967

REFERENCES

(*1*) RIVERA, J. Strontium-90 in human vertebrae, 1962–1963. Radiol Health Data 5:511–513 (October 1964).

(*2*) WEISS, E. S., W. H. LAND, K. H. FALTER, and R. M. HALLISEY. Strontium-90 content of human bones, 1961–1963. Radiol Health Data 5:231–239 (May 1964).

(*3*) PUBLIC HEALTH SERVICE, NORTHEASTERN RADIOLOGICAL HEALTH LABORATORY. Analysis of environmental samples, chemical and radiochemical procedures, NERHL 64-1. Northeastern Radiological Health Laboratory, Winchester, Mass. (April 1964).

(*4*) GAFFNEY, G. W., R. M. HALLISEY, M. S. MILLER, and A. S. GOLDIN. Strontium-90 in human bone, 1962–1963. Radiol Health Data 5:620–628 (December 1964).

(*5*) HALLISEY, R. M., and M. A. WALL. Strontium-90 in human bone, 1964–1965. Radiol Health Data Rep 8:415–419 (August 1967).

Environmental Levels of Radioactivity at Atomic Energy Commission Installation

The U. S. Atomic Energy Commission receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major AEC installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the AEC Manual.[1]

Summaries of data from the environmental radioactivity monitoring reports follow for the Atomics International and Savannah River Plant.

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[1] Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation," contains essentially the standards published in Chapter 0524 of the AEC Manual.

1. Atomics International[1]
July–December 1967

North American Rockwell Corporation
Canoga Park, California

Atomics International, a division of North American Rockwell Corporation, has been engaged in atomic energy research and development since 1946. The company designs, develops, and constructs nuclear reactors for central station and compact power plants and for medical, industrial, and scientific applications.

The company headquarters is located in Canoga Park, Calif., approximately 23 miles northwest of downtown Los Angeles. The 290-acre Nuclear Development Field Laboratory (Santa Susana Facility), equipped with extensive testing facilities for the support of advanced nuclear studies, is in Ventura County, in the Simi Hills approximately 29 miles northwest of downtown Los Angeles. The location of the above sites in relation to nearby communities is shown in figure 1.

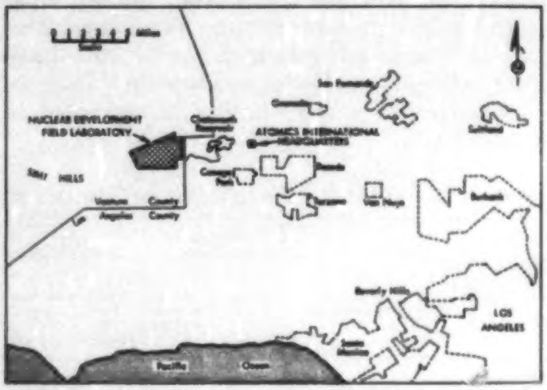

Figure 1. Atomics International facilities and vicinity

The basic concept of radiological hazard control at Atomics International encourages total containment of radioactive materials and, through rigid operational controls, minimizes effluent releases and external radiation levels. The environmental monitoring program provides a check on the effectiveness of radiological safety procedures and of engineering safeguards incorporated into facility design.

The environs of Atomics International headquarters and Nuclear Development Field Laboratory (NDFL) are surveyed monthly to determine the concentration of radioactivity in typical surface soil, vegetation, and water samples. In addition, continuous environmental air monitoring at the sites provides information concerning airborne particulate radioactivity.

Air monitoring

Environmental air sampling is conducted continuously at the headquarters and NDFL sites with automatic air samplers operating on 24-hour sampling cycles. Airborne particulate radioactivity is collected on HV–70 filter paper which is automatically changed at the end of each sampling period. The filter is removed from the sampler and counted after the radioactivity is allowed to decay for at least 72 hours. The volume of a typical daily environmental air sample is approximately 20-cubic meters. The average concentration of long lived beta-gamma radioactivity on airborne particulates is presented in table 1 for the first and the last half of 1967.

Table 1. Beta-gamma radioactivity of airborne particulates, Atomics International, 1967

Location	January-June 1967		July-December 1967	
	Number of samples	Average concentration (pCi/m^3)	Number of samples	Average concentration (pCi/m^3)
Headquarters	353	0.08	359	0.10
NDFL	1,243	0.06	1,157	0.12

Water monitoring

Process water used at the NDFL is obtained from Ventura County Water District No. 10 and distributed onsite by the same piping system previously used when process water was supplied by onsite wells. Pressure is provided by elevated storage tanks, one 50,000-gallon and one 500,000-gallon tank onsite. While clinically potable, the water is not used for drinking. Bottled potable water is delivered by a vendor and is not analyzed. Water from the

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[1] Summarized from "Environmental Monitoring, semiannual report, July 1, 1967 to December 31, 1967 and annual report 1967," Atomics International, Division of North American Rockwell Corporation.

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pipe system is sampled monthly at two locations. The average radioactivity concentration in process water is presented in table 2.

Table 2. Process water radioactivity, NDFL site Atomics International, 1967

Type of radioactivity	January-June 1967		July-December 1967	
	Number of samples	Average concentration (pCi/liter)	Number of samples	Average concentration (pCi/liter)
Alpha	12	0.06	12	0.016
Beta-gamma	12	[a] 6.8	12	5.5

[a] Erroneously reported as 3.4 pCi/liter for the first half of 1967.

Water samples are also collected monthly at Chatsworth Reservoir which is operated by the Los Angeles City Department of Water and Power. Normally, one water sample is obtained from the lake surface and a second sample is obtained from the reservoir water supply inlet located on the north side of the lake. The average radioactivity for both surface and supply water samples is presented in table 3.

Table 3. Chatsworth Reservoir water radioactivity Atomics International, 1967

Sample	Type of radioactivity	January-June 1967		July-December 1967	
		Number of samples	Average concentration (pCi/liter)	Number of samples	Average concentration (pCi/liter)
Lake surface	Alpha	6	0.29	6	0.32
	Beta-gamma	6	8.7	6	7.6
Supply inlet	Alpha	6	0.26	6	0.30
	Beta-gamma	6	6.5	6	5.5

Surface discharged waters from NDFL facilities drain into holding reservoirs on adjacent property. When full, the main reservoir is drained into Bell Creek, a tributary of the Los Angeles River in the San Fernando Valley, Los Angeles County. Pursuant to the requirements of Los Angeles Regional Water Quality Control Board Resolution 66–49 of September 21, 1966, an environmental sampling station has been established in Bell Creek Canyon approximately 3.4 miles downstream from the south NARC Boundary. Samples, obtained and analyzed monthly, include stream-bed mud, vegetation, and water. Average radioactivity concentrations in the main holding reservoir and Bell Creek samples are presented in table 4.

Table 4. Radioactivity in the Main Holding reservoir[a] and Bell Creek, Atomics International July–December 1967

Sample description (units)	Number of samples	Alpha radioactivity	Beta radioactivity
Reservoir station 6 [a] (pCi/liter)	6	0.18	7.5
Reservoir station 12 [a] (pCi/liter)	6	.16	7.0
Bell Creek mud (pCi/g)	6	.41	25
Bell Creek vegetation (pCi/g ash)	6	.42	120
Bell Creek water (pCi/liter)	6	.06	4.2

[a] Locations not shown on figure 1.

Soil and vegetation monitoring

Soil and vegetation are regularly sampled at 24 locations. Twelve sampling stations are located within the boundaries of Atomics International's sites and are referred to as "onsite" stations. The remaining 12 stations, located within a 10-mile radius of the sites, are referred to as "offsite" stations.

Surface soil types available for sampling range from decomposed granite to clay and loam. Samples are taken from the top half-inch layer of ground surface. The soil samples are packaged and sealed in plastic containers and returned to the laboratory for analysis. Radioactivity in soil samples is presented in table 5.

Table 5. Radioactivity in the soil, Atomics International

Area	Type of radioactivity	January-June 1967		July-December 1967	
		Number of samples	Average concentration (pCi/g)	Number of samples	Average concentration (pCi/g)
Onsite	Alpha	72	0.40	72	0.43
	Beta-gamma	72	27	72	28
Offsite	Alpha	24	0.36	24	0.41
	Beta-gamma	24	25	24	24

Vegetation samples obtained in the field are of the same plant type wherever possible, generally, sunflower or wild tobacco plant leaves. These types maintain a more active growth rate during the dry season than do most natural vegetation indigenous to the local area. Vegetation leaves are stripped from plants and transferred to the laboratory for analysis.

Plant root systems are not routinely sampled. Radioactivity in vegetation samples is presented in table 6.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
Second half of 1966	August 1967
First half 1967	March 1968

Table 6. Radioactivity in vegetation, Atomics International

Area	Type of radioactivity	January-June 1967		July-December 1967	
		Number of samples	Average concentration (pCi/g ash)	Number of samples	Average concentration (pCi/g ash)
Onsite	Alpha	72	0.48	72	0.74
	Beta-gamma	72	425	72	147
Offsite	Alpha	24	0.32	24	0.44
	Beta-gamma	24	658	24	167

2. Savannah River Plant[2]
July–December 1967

E. I. duPont de Nemours
Aiken, South Carolina

The Savannah River Plant (SRP), built and operated for the Atomic Energy Commission by E. I. duPont de Nemours and Company, occupies an area of 312-square miles along the Savannah River, 22 miles downstream from Augusta, Ga. Production facilities include a fuel preparation area, four reactors, two fuel separation areas, and a heavy water production plant. A basic goal in plant operation is total containment of radioactive waste. Although some very low-level gaseous and liquid wastes are discharged to the environment in controlled releases, dispersal is adequate to ensure environmental concentrations below recommended guides.

The DuPont environmental monitoring group has maintained a continuous monitoring program since 1951 (before plant startup) to determine the concentrations of radioactive materials in a 1,200-square mile area outside the plant. Included in this area are parts of Aiken, Barnwell, and Allendale counties in South Carolina, and Richmond, Burke, and Screven counties in Georgia. This surveillance determines the magnitude and origin of any radioactivity above natural levels. Measured concentrations of radionuclides in air, water, and milk are compared with the maximum permissible concentrations (MPC) recommended by the International Commission on Radiological Protection (ICRP), or the daily intake guides recommended by the Federal Radiation Council (FRC).

Sensitive instruments, which can detect traces of radioactive materials far below concentrations of hazard significance, are used to determine radioactivity in the environs. Plant-released radioactivity cannot be readily distinguished from weapons tests fallout, and both are included in the reported concentrations. Maximum and minimum values given are for individual samples collected during the report period.

Atmospheric monitoring

Concentrations of radioactive materials in the atmosphere were measured by biweekly analyses of air filters collected at five monitoring stations near the plant perimeter and 10 stations around a circle of about 25-miles radius from the center of the plant (figure 2). Deposition rates of radioactive material at each station were also determined by monthly analyses of rainwater ion exchange columns (fallout collectors). The monitoring stations are spaced so that a significant release of airborne radioactivity by SRP would be detected regardless of the prevailing wind. All stations operate continuously. Four additional air monitoring stations at Savannah and Macon, Ga., and at Columbia and Greenville, S.C., are so distant from SRP that the effect of SRP operations is negligible; they are reference points for determining background radioactiv-

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[2] Summarized from "Effect of the Savannah River Plant on Environmental Radioactivity, Semiannual Report, July–December 1967," DPST 68-30-1.

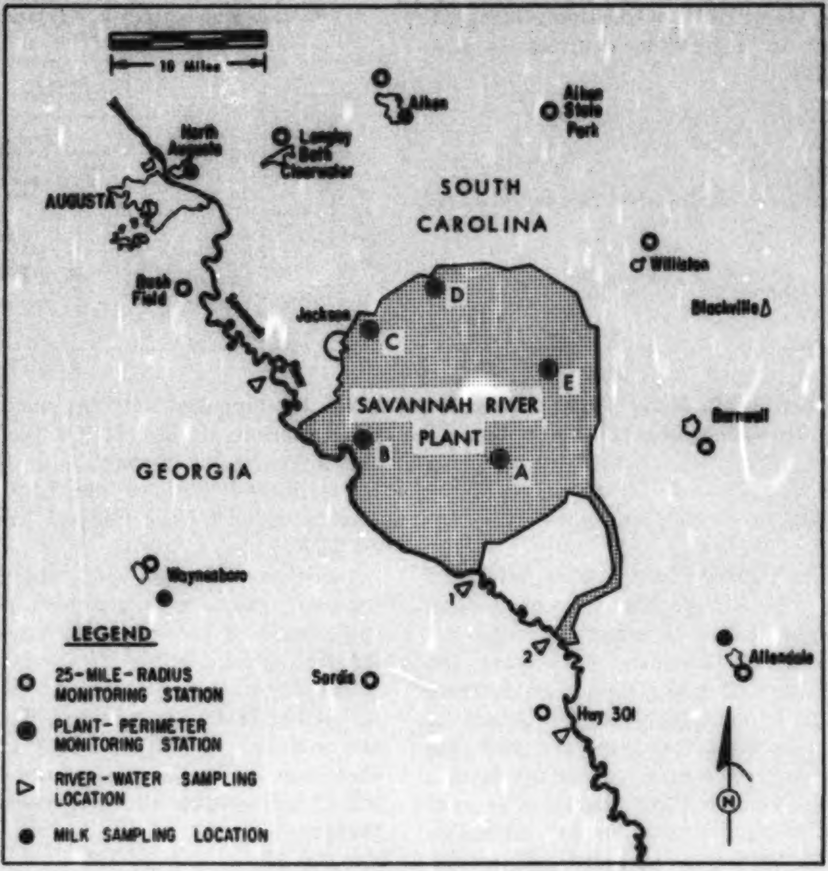
10 Miles
North Augusta
Langley
Bath
Clearwater
Aiken
Aiken State Park
AUGUSTA
SOUTH CAROLINA
Williston
Blackville
Bush Field
Jackson
D
C
E
SAVANNAH RIVER PLANT
B
A
Barnwell
GEORGIA
Waynesboro
1
2
Allendale
Sardis
Hwy 301
N
LEGEND
○ 25-MILE-RADIUS MONITORING STATION
● PLANT-PERIMETER MONITORING STATION
▷ RIVER-WATER SAMPLING LOCATION
● MILK SAMPLING LOCATION

Figure 2. Environmental sampling locations, Savannah River Plant

ity levels (figure 3). This system permits comprehensive surveillance of atmospheric radioactivity and also makes it possible to differentiate between weapons test fallout and SRP releases.

The small amount of filterable beta radioactivity released to the atmosphere, primarily from the fuel separations areas, was obscured by fallout. The influence of the nuclear tests which resumed in September 1961 is shown in figure 4. The rises in early 1964, 1965, and 1966 were the result of the anticipated spring increases in the mixing of stratospheric debris into the troposphere. The concentrations of radionuclides in air during July–December 1967, were the lowest ever observed in this area.

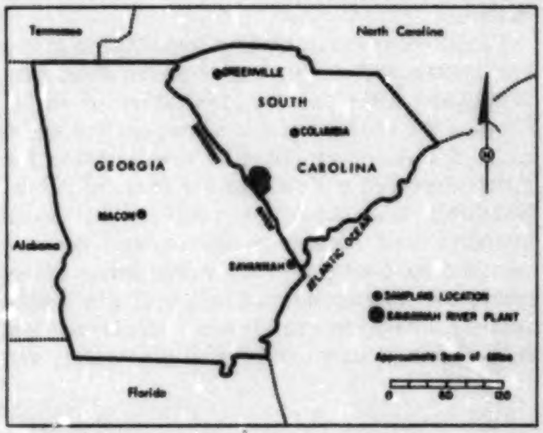
Tennessee
North Carolina
GREENVILLE
SOUTH CAROLINA
COLUMBIA
GEORGIA
MACON
Alabama
SAVANNAH
ATLANTIC OCEAN
SAMPLING LOCATION
SAVANNAH RIVER PLANT
Approximate Scale of Miles
0
60
120
Florida
N

Figure 3. Distant air monitoring stations, Savannah River Plant

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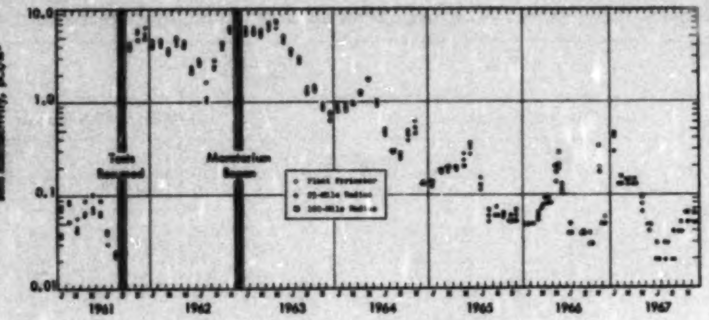

Figure 4. Influence of weapons tests

Radioactivity in air, determined from filter analyses, is shown in table 7. The July–December 1967 concentrations of filterable beta radioactivity (0.03 pCi/m³) and alpha radioactivity (0.0006 pCi/m³) in air were 0.03 and 0.8 percent of the respective MPC's. Tritium oxide concentrations in air, at the plant perimeter and at the 25-mile stations, did not exceed 0.1 percent of the MPC. Iodine-131 concentrations in routine air samples were less than 0.02 pCi/m³, the lower detection limit, throughout the period.

Deposition of fallout during July–December 1967 totaled 1 nCi/m² at the plant perimeter locations and 1 nCi/m² at 25-mile radius locations; comparable values for the first half of 1967 were 23 and 20 nCi/m². Deposition at each sampling location is presented in table 8.

Algae and fish in Savannah River

Fish, predominantly bream, and indigenous algae, primarily green (*Vaucheria*) and blue-green (*Phormidium*), were collected weekly upstream from, adjacent to and downstream from the Savannah River Plant. Determination of radionuclides in algae is important because algae concentrate certain radionuclides and also because of the role of algae in the food chain of aquatic organisms. Beta radioactivity concentrations in algae and fish adjacent to and downstream from SRP indicate some minor contribution by SRP. Although measurably higher

Table 7. Radioactivity in air, Savannah River Plant, July–December 1967

Filter analysis	Average concentrations (pCi/m³)																
	Plant perimeter locations						25-mile radius locations										
	A	B	C	D	E	Average	Aiken airport	Aiken State Park	Allendale	Barnwell	Bush Field	Langley	Sardis	Waynesboro	Williston	Highway 301	Average
Alpha particle emitters [a] (multiply by 10^{-3})																	
Maximum	1.3	1.2	2.3	1.9	1.5		1.2	1.3	1.4	1.3	1.3	1.2	1.7	1.2	1.2	1.5	
Minimum	.3	ND	0.4	ND	ND		0.3	0.4	ND	0.4	0.4	0.4	0.3	0.4	0.3	ND	
Average	.7	.7	1.0	0.9	0.7	0.8	0.8	0.7	0.6	0.6	0.8	0.7	0.7	0.7	0.6	0.6	0.7
Nonvolatile beta-particle emitters [b]																	
Maximum	0.07	0.07	0.05	0.10	0.06		0.05	0.05	0.04	0.07	0.05	0.03	0.03	0.06	0.07	0.05	
Minimum	.02	ND	.02	.02	.02		.02	.02	.02	.02	.02	.02	.02	.02	.02	.01	
Average	.03	.03	.04	.04	.03	.03	.03	.02	.02	.03	.03	.02	.02	.03	.03	.03	.03
Specific radionuclides (averages)	Composite sample						Composite sample										
Strontium-89, 90	<0.005						<0.003										
Cesium-137	< .006						< .005										
Cerium-141, -144	< .01						< .01										
Zirconium-niobium-95	< .02						< .02										

[a] Sensitivity of analysis—3.0 x 10^{-4} pCi/m³; ICRP Maximum Permissible Concentration: 0.07 pCi/m³.
[b] Sensitivity of analysis—0.006 pCi/m³; ICRP Maximum Permissible Concentration: 100 pCi/m³.
ND, nondetectable, less than sensitivity of analysis.

Table 8. Total fallout deposited, Savannah River Plant, July–December 1967

Radionuclide	Deposition (nCi/m²)																
	Plant perimeter locations						25-mile radius locations										
	A	B	C	D	E	Average	Aiken airport	Aiken State Park	Allendale	Barnwell	Bush Field	Langley	Sardis	Waynesboro	Williston	Highway 301	Average
Alpha *	3.05	1.85	1.81	2.01	2.66	2.28	1.27	1.93	1.62	0.54	1.47	2.62	1.39	1.93	3.09	1.85	1.78
Strontium-89	0.12	0.19	0.04	ND	0.08	0.08	ND	ND	0.31	.27	ND	0.12	0.12	0.06	ND	0.15	0.12
Strontium-90	.23	.23	.27	0.35	.31	.27	0.15	0.31	.12	.12	0.27	.15	.19	.15	0.19	.19	.19
Cesium-137	.69	.93	.42	.58	.35	.58	.27	.27	.12	ND	.69	.50	.96	.46	.12	.66	.39
Cerium-141, -144	ND	ND	ND	.58	ND	.12	.62	ND	ND	.58	ND	ND	ND	ND	ND	.54	.15
Zirconium-niobium-95	.19	ND	.12	.08	.15	.12	.08	.23	.12	ND	.15	.19	.35	ND	ND	.06	.12
Beryllium-7	16.13	12.31	9.42	14.24	9.15	12.24	13.12	7.60	6.10	2.24	8.96	11.72	7.18	6.33	7.76	7.72	7.67

* Multiply by 10^{-3}
ND, nondetectable, less than sensitivity of analysis.

than similar material collected at the control station 3 miles upstream from SRP, the slight increase is of no biological significance.

Specific radionuclide analyses were made on algae and fish collected from the Savannah River. Radiocesium and radiostrontium were found consistently in river algae; whereas cerium-141, -144, chromium-51, zirconium-niobium-95, manganese-54, zinc-65, and cobalt-60 were detected less frequently. Also, radiostrontium (maximum, 18 pCi/g, wet weight) was detected in bone tissue of river fish, and radiocesium (maximum 41 pCi/g, wet weight) was detected in the flesh tissue. Radiozinc and phosphorus-32 were detected less frequently in these tissues. The maximum concentrations of phosphorus-32 detected in bone and flesh tissues of river fish were 102 pCi/g and 17 pCi/g, respectively.

Water monitoring

The plant site is drained by five streams which flow several miles through the reservation before reaching the river (figure 5). In January 1965, the Beaufort-Jasper Water Authority began operation of a new treatment facility to furnish drinking water, partially supplied from the Savannah River, to most of Beaufort County, South Carolina. Water is supplied through a new canal from the river at a location about 90 miles below the SRP. The city of Savannah also supplements its domestic well water supply with river water during periods of peak demand.

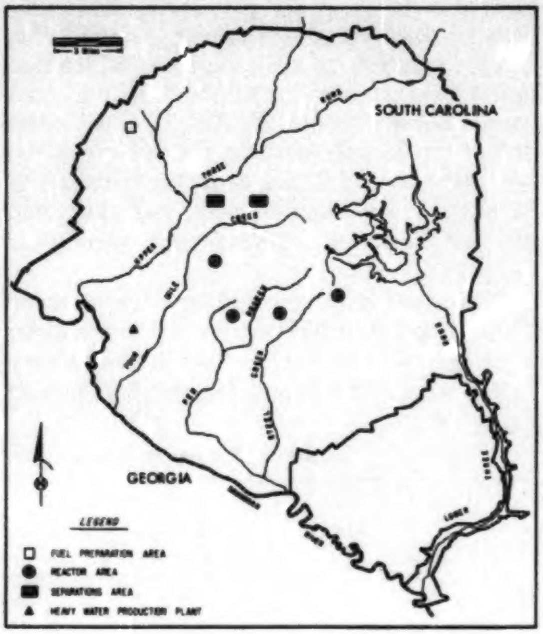

Figure 5. SRP production and effluent streams

Communities near SRP get domestic water from deep wells or surface streams. Public water samples were collected and analyzed from 14 surrounding towns in October. There was no evidence that SRP contributed radioactivity to drinking water supplies; concentrations of alpha radioactivity (1.2 pCi/liter) and beta radioactivity (6 pCi/liter) were essentially the same as those observed before plant startup.

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River water, analyzed weekly, was sampled continuously at four locations, as shown in figure 2. Average concentrations of specific radionuclides found in river water during July–December 1967 are in table 9.

Table 9. Average concentration of radionuclides in Savannah River water, July–December 1967

Radionuclide	Concentration (pCi/liter)			
	Sensitivity of analysis	Control (3 miles upstream from plant)	Highway 301 (10 miles downstream from plant)	Percent MPC at Highway 301
Tritium-3	600	800	7,400	0.25
Ruthenium-103, -106	3.2	ND	ND	<0.03
Cerium-141, -144	2.5	ND	ND	<0.02
Cesium-134, -137	0.6	ND	1.6	<0.01
Neptunium-239	2.2	ND	1.7	<0.002
Barium-lanthanum-140	1.6	ND	ND	<0.01
Zirconium-niobium-95	0.5	ND	ND	<0.001
Chromium-51	4.3	ND	0.7	0.0003
Strontium-89	0.3	ND	1.5	0.05
Iodine-131	0.5	ND	0.7	0.23
Strontium-90	0.01	0.6	1.0	0.25
Cobalt-60	1.4	ND	ND	<0.003
Zinc-65	1.1	ND	ND	<0.001
Manganese-54	0.4	ND	ND	<0.0004

ND, nondetectable, less than sensitivity of analysis.

Tritium, and trace amounts of cesium–137, neptunium–239, iodine–131, chromium–51, strontium–89, and strontium–90, released mainly from reactor areas, were the radionuclides of SRP origin detectable in river water at the downstream location. Strontium–90 and tritium from worldwide fallout were also detected in river water upstream from SRP. The tritium concentrations in raw water collected from the Beaufort-Jasper Water Plant averaged 4,000 pCi/liter (0.1 percent of the MPC) during the 6-month report period. The annual radiation exposure of an individual in this population due to the consumption of water containing the very low concentration of tritium is only 0.4 mrem. The radiation dose was determined by analysis of urine (99 samples) collected from Beaufort residents during 1967.

Tritium, a beta-particle emitter and the most abundant radionuclide released to the river, is produced by neutron irradiation of heavy water moderator in the reactors. Chronium–51, the second most abundant radionuclide released to the river, is produced by neutron irradiation of stable chromium (a component of the stainless steel used in reactor parts). The tritium and chromium–51 concentrations in river water averaged 0.25 and 0.0003 percent of the MPC, respectively.

Vegetation

Radioactive contamination of growing plants may result from deposition on foliar surfaces or absorption of radioactive materials from the soil.

Grass samples were collected at seven locations along the plant perimeter and at nine other locations along a 25-mile radius route. (These are not designated on figure 2). Samples from each quadrant of the plant site and of the surrounding area were composited for monthly analysis. Radionuclides in grass samples were from fallout. Alpha-particle emitters averaged 0.1 pCi/g at the plant perimeter and 25-mile radius locations as compared to 0.2 pCi/g during January–June 1967; gamma-ray emitters averaged 4.8 and 5.3 pCi/g, respectively, as compared to 32 and 37 pCi/g for January–June 1967.

Milk

Milk was sampled at three dairies within a 25-mile radius of SRP, as shown in figure 2. Samples which were collected biweekly, were analyzed for tritium, radiocesium, and radioiodine. Strontium–90 determinations were made quarterly. Milk produced in the area and sold by major distributors was also analyzed for these radionuclides. Results from analyzing milk for radioactivity during July–December 1967 are in table 10.

Table 10. Radioactivity in milk from local dairies Savannah River Plant, July–December 1967

Location of local dairies	Concentration (pCi/liter)				
	Tritium [a]			Strontium-90 [b]	
	Maximum	Minimum	Average	Sept 1967	Dec 1967
Aiken	5.0×10^3	ND	ND	13	16
North Augusta	8.0×10^3	ND	ND	12	11
Waynesboro	7.0×10^3	ND	ND	14	8
Major distributors [c]	6.0×10^3	ND	ND	9	10

[a] Sensitivity of analysis—3,000 pCi/liter.
[b] Sensitivity of analysis 1.0 pCi/liter.
[c] Milk produced in local dairies, but sold by major distributors.
ND, nondetectable, less than sensitivity of analysis.

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Average concentrations of three radionuclides in milk (less than 30 pCi/liter for cesium–137, 12 pCi/liter for strontium–90, and less than 5 pCi/liter for iodine–131) were consistent with values reported by the U.S. Public Health Service for most sections of the United States during July–December 1967. Tritium in local milk, when present, is assumed to be associated with plant operations. The average tritium level was less than the sensitivity of the analysis, which allows detection of concentrations of 3,000 pCi/liter (1 percent of the MPC for water).

Food

Sixty-two samples representing 4 food categories (fruit, grain, leafy vegetable, and poultry) were collected during the summer and fall of 1967 at 14 localities in the 6 countries surrounding SRP (not shown on figure 5). With the exception of grains, all foods were prepared for analysis in a manner similar to that used to prepare them for eating. Peelings, seeds, and other nonedible parts were removed.

Wheat, containing the whole grains only, and oats, containing both grains and husks, were processed unwashed. Gamma-ray spectrometry was used to analyze samples for cerium–141, –144, ruthenium–103, –106, iodine–131, cesium–137, manganese–54, and zirconium-niobium–95. Radiostrontium and alpha radioactivity (uranium and plutonium) were determined by radiochemical analysis.

SRP contribution to the levels of radioactivity in foods were so low in 1967 as to be indistinguishable from fallout. With the exception of cesium–137 and strontium–90, all radionuclides in food were near or below levels of detection. The amount of strontium–90 and cesium–137 were slightly lower than during 1966; maximum concentrations were 0.62 pCi/g for strontium–90 in collards and 0.08 pCi/g for cesium–137 in grain. Alpha radioactivity in food was about the same as in the 1966 samples (table 11).

Table 11. Radioactivity in agricultural products Savannah River Plant, 1967

Products	Number of samples	Concentration (pCi/g wet weight)					
		Strontium-90		Cesium-137		Alpha emitters	
		Average	Maximum	Average	Maximum	Average	Maximum
Collards	14	0.61	1.08	ND	0.07	0.055	0.220
Plums	14	.02	.04	ND	.09	.002	.004
Oats, rye and wheat	14	.18	.35	0.08	.14	.006	.023
Corn	14	.02	.05	.06	.21	.002	.006
Chicken	6	.03	.06	ND	.04	.003	.007
Sensitivity of analysis		.02		.02		.002	

ND, nondetectable.

Environmental gamma radiation levels

Monthly measurements of environmental gamma radiation were made with thermoluminescent dosimeters. The July–December 1967 data (shown in table 12), are characteristic of measurements observed at individual stations for the past several years.

Recent coverage in *Radiological Health Data and Reports:*

Period	Issue
July–December 1966	September 1967
January–June 1967	February 1968

Table 12. Environmental gamma radiation, Savannah River Plant, July–December 1967

Filter analysis	Exposure (mR/day)																
	Plant perimeter locations						25-mile radius locations										
	A	B	C	D	E	Average	Aiken Airport	Aiken State Park	Allendale	Barnwell	Bush Field	Langley	Sardis	Waynesboro	Williston	Highway 301	Average
Maximum	0.50	0.28	0.41	0.29	0.33		0.22	0.24	0.30	0.36	0.36	0.35	0.33	0.31	0.27	0.35	
Minimum	.18	.16	.20	.15	.17		.16	.13	.19	.16	.17	.19	.18	.17	.18	.19	
Average	.29	.22	.26	.21	.24	0.24	.20	.17	.24	.24	.24	.25	.24	.23	.22	.24	0.23

Reported Nuclear Detonations, May 1968

The U.S. Atomic Energy Commission announced one underground nuclear test for the month of May. On May 17, 1968, an underground nuclear test of low-intermediate yield (20 to 200 kilotons TNT equivalent) was conducted at the AEC Nevada Test Site.

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